Supporting Information

Regioselective tandem sulfonylation/cyclization of unsaturated *N*-substituted enamides with sulfonyl chlorides by copper catalysis

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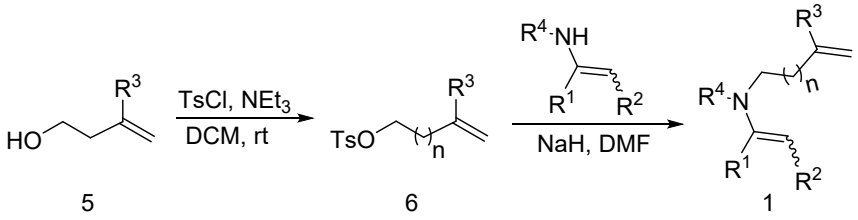
1. General information

Unless otherwise noted, all reagents and solvents were purchased from commercial suppliers and used without further purification. Substituted acetophenone were purchased from Leyan Company and used directly. ^{1}H-NMR and ^{13}C-NMR spectra were recorded at 25 ºC on Bruker Advance 600M spectrometers ($CDCl_3$, DMSO as solvent). Chemical shifts for ^{1}H NMR spectra are reported as δ in units of parts per million (ppm) downfield from $SiMe_4$ (δ 0.0) and relative to the signal of $SiMe_4$ (δ 0.00 singlet). Multiplicities were given as: s (singlet); d (doublet); t (triplet); q (quartet); dd (doublet of doublets); dt (doublet of triplets); m (multiplets) and *etc*. Coupling constants are reported as a *J* value in Hz. ^{13}C NMR spectra are reported as δ in units of parts per million (ppm) downfield from $SiMe_4$ (δ 0.0) and relative to the signal of chloroform-d (δ 77.00 triplet). High resolution mass spectral analysis (HRMS) was performed on an Agilent Technologies 6540 UHD Accurate-Mass Q-TOF LC/MS (ESI) instrument. Flash chromatography was performed using 200-300 mesh silica gel with the indicated solvent system.

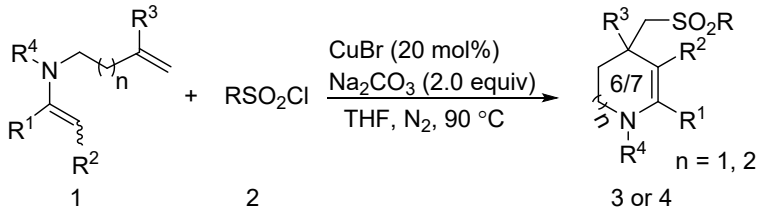
2. Preparation of starting materials 1a-1u



To a solution of hydroxylated alkenes 5 (30 mmol, 1.0 equiv), Et_3N (33 mmol, 1.1 equiv) in dry CH_2Cl_2 (50 mL) was added TsCl (33 mmol, 1.1 equiv) and the resulting mixture stirred at room temperature for 24 h. The reaction mixture was quenched with saturated $NaHCO_3$ (15 mL) and extracted with CH_2Cl_2 (3 × 30 mL). The combined organic layers were dried by Na_2SO_4, filtered and concentrated in vacuo. Purification via column chromatography PE/EtOAc (9:1) to yield the title compound 6 as a colorless oil.

NaH (60% dispersion in mineral oil, 1.5 equiv) was added to the mixture of enamide (5.0 mmol, 1.0 equiv) and dry DMF (10 mL) at 0 °C. The resulting suspension was stirred at 0 °C for 30 min. 7.5 mmol (1.5 equiv) of compound 6 was then added drop wise and the solution was warmed to room temperature overnight. The completion of the reaction was confirmed by checking TLC. After finishing, the reaction was quenched by adding 2 mL of water at 0 °C. The organic layer was extracted with ethyl acetate through stages of extraction with water. The combined organic layer was concentrated under reduced pressure and the pure product was isolated by flash column chromatography (PE/EtOAc).

3. Procedure for the synthesis of compound 3 or 4.



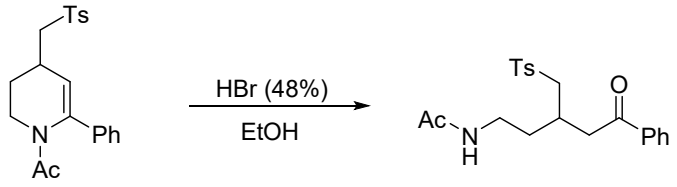
A dry 25-mL Schlenk tube containing a magnetic stirring bar was charged with unsaturated *N*-substituted enamides **1** (0.1 mmol), sulfonyl chlorides **2** (0.2 mmol), CuBr (20 mol%), Na_2CO_3 (2.0 equiv), THF (1 mL), Then the mixture was charged with N_2 and heated at 90 °C oil bath for 20 h. After finishing, the reaction mixture was concentrated on a rotary evaporator and the residue was directly subjected to flash

column chromatography on silica gel with (20-30% EtOAc/Petroleum ether) as eluate to furnish the desired product.

4. 1 Mmol-scale reaction for the preparation of product 3a

A mixture of dienes **1a** (1 mmol), 4-Methoxybenzenesulfonyl chloride **2a** (2.0 equiv), CuBr (20 mol%), Na_2CO_3 (2.0 equiv), THF (5 mL), were charged with N_2 and heated at 90 ^oC oil bath for 20 h. After finishing, the reaction mixture was concentrated on a rotary evaporator and the residue was directly subjected to flash column chromatography on silica gel with (20-30% EtOAc/Petroleum ether) as eluate to furnish the desired product 3a (78%).

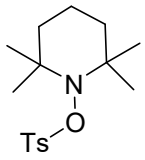
5. Procedures for the formation of 3aa.

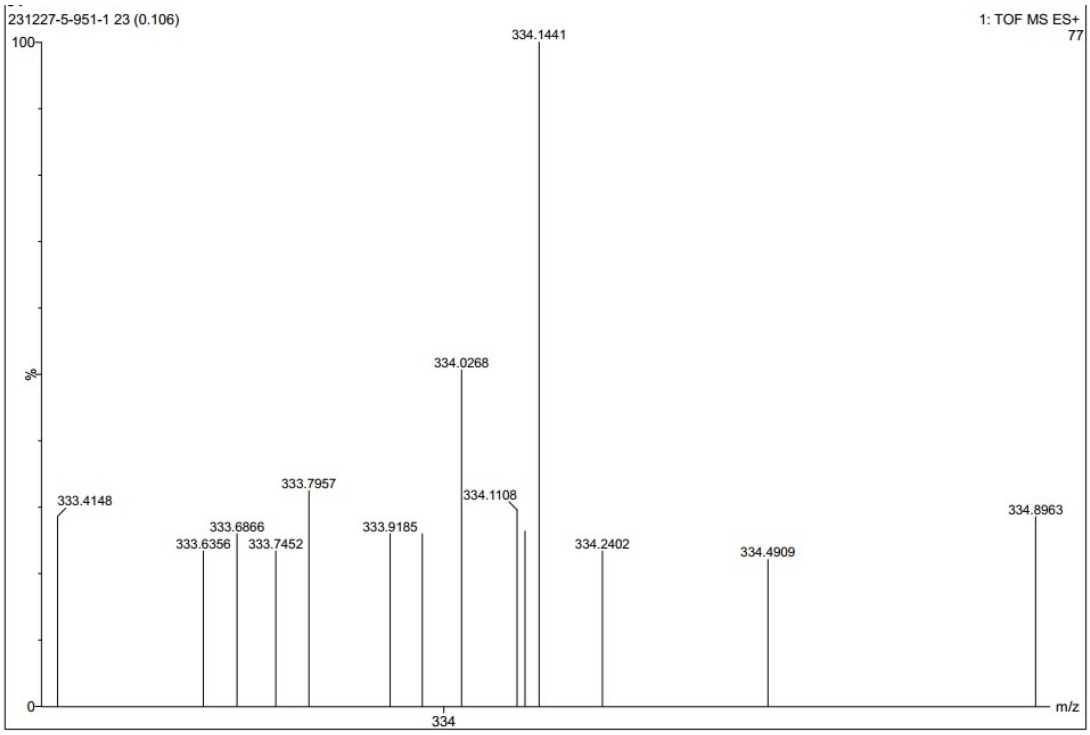


3a **3aa**

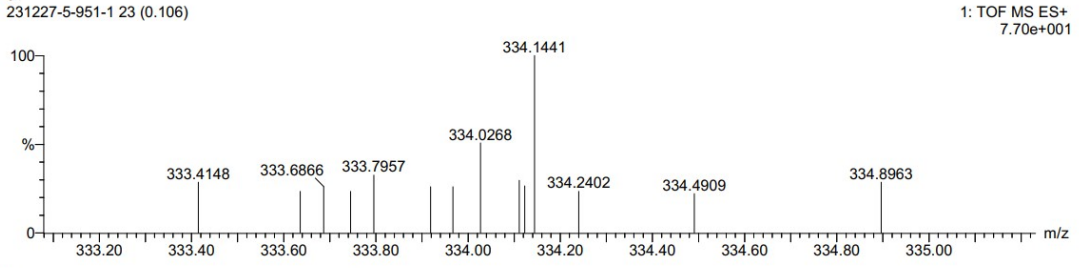
48% aqueous solution of HBr (1.0 mL) was added to the mixture of **3a** (0.3 mmol) and EtOH (4 mL) at 0 ^oC. After the reaction finished as indicated by TLC, the reaction mixture was quenched by addition of saturated aqueous $NaHCO_3$ at 0 °C and extracted with 10 mL dichloromethane for 3 times. The combined organic layers were washed with water, saturated brine, dried over $CaCl_2$, concentrated in vacuo and purified by chromatography on silica gel with (30% EtOAc/Petroleum ether) as eluate to furnish the desired product **3aa**.

6. The radical trapping reaction residue was analyzed by high resolution mass spectrometry (HRMS)

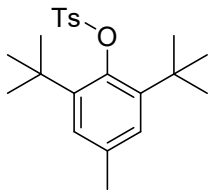


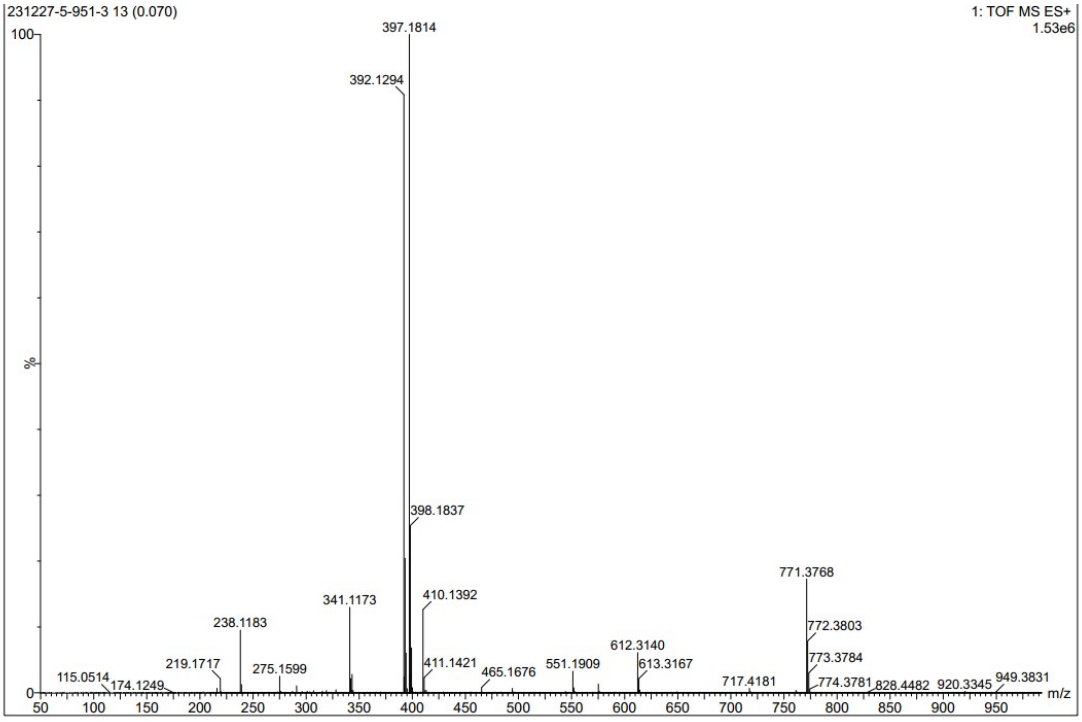


Monoisotopic Mass, Even Electron Ions
1905 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)
Elements Used:
C: 16-16 H: 25-25 N: 0-20 O: 0-100 Na: 0-3 S: 1-4
31
231227-5-951-1 23 (0.106)



Minimum:				-1.5				
Maximum:		5.0	10.0	50.0				
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	Norm	Conf(%)	Formula
334.1441	334.1453	-1.2	-3.6	4.5	34.6	n/a	n/a	C16 H25 N O3 Na S





Monoisotopic Mass, Even Electron Ions
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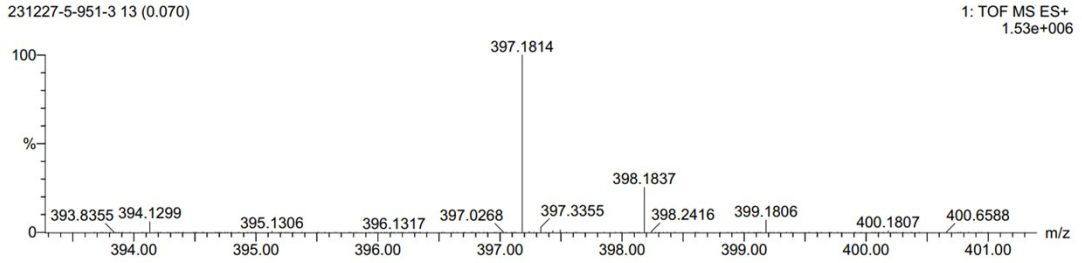
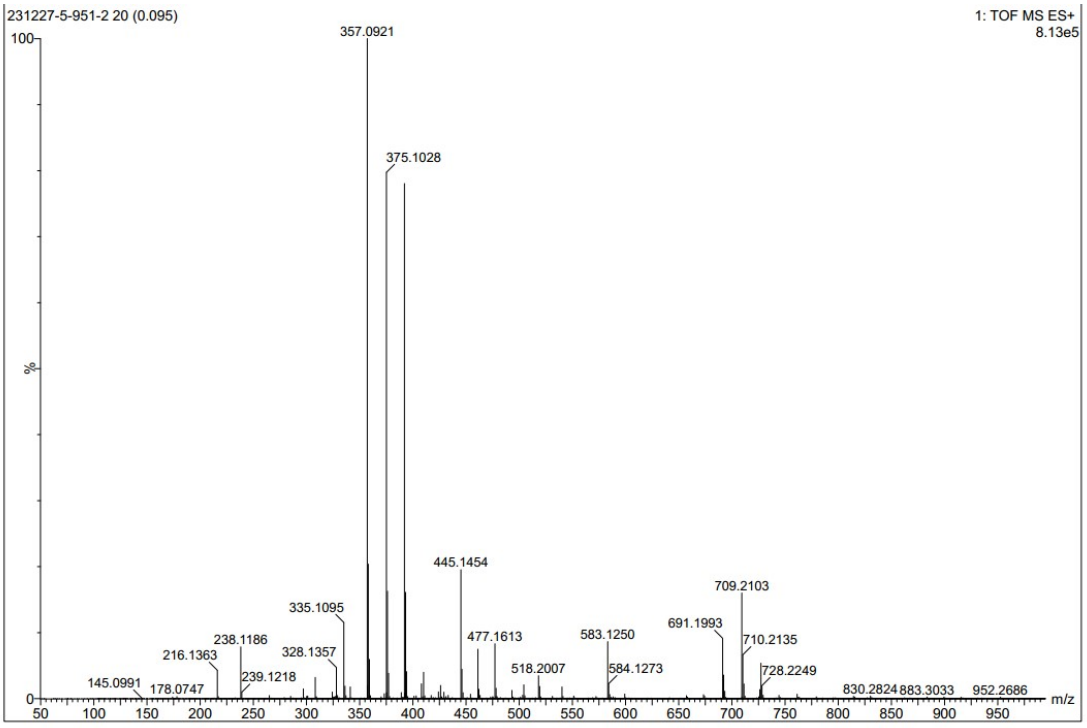
31



Minimum:				-1.5				
Maximum:		5.0	10.0	50.0				
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	Norm	Conf(%)	Formula
397.1814	397.1813	0.1	0.3	7.5	389.3	n/a	n/a	C22 H30 O3 Na S



Monoisotopic Mass, Even Electron Ions
2391 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)
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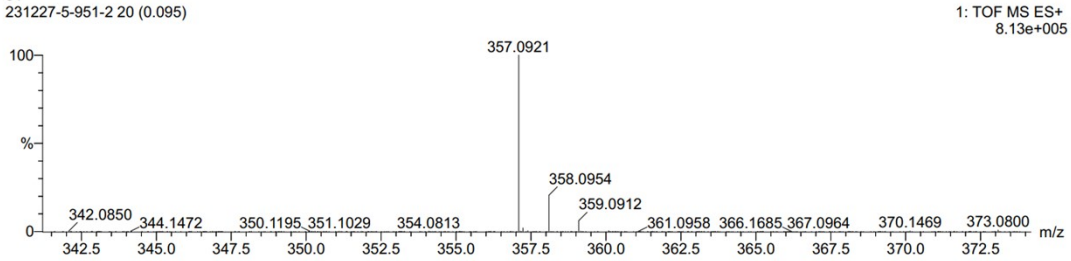
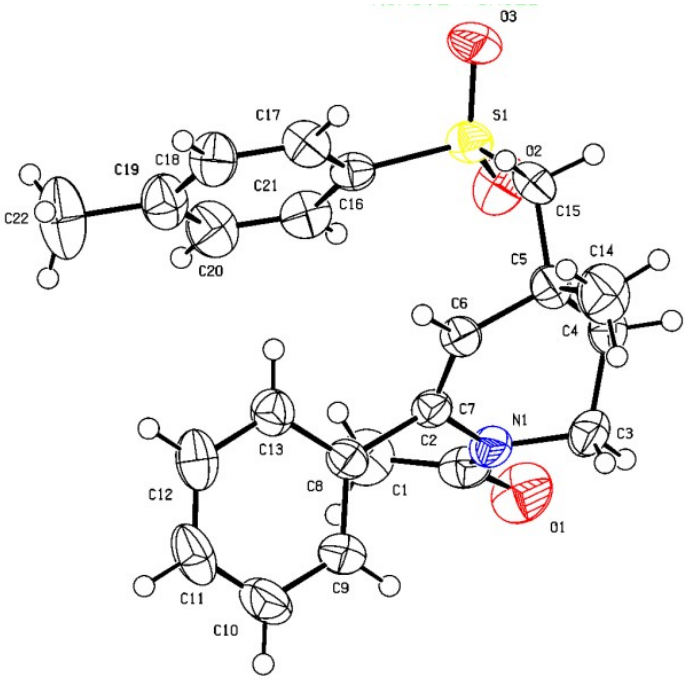
31



Minimum:				-1.5				
Maximum:		5.0	10.0	50.0				
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	Norm	Conf(%)	Formula
357.0921	357.0925	-0.4	-1.1	12.5	295.5	n/a	n/a	C21 H18 O2 Na S

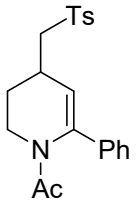
7. X-ray diffraction analysis of compound 3r.



Bond precision: C-C = 0.0027 A Wavelength=0.71073
Cell: a=8.5137(12) b=16.661(3) c=14.8228(19)
alpha=90 beta=92.652(6) gamma=90
Temperature: 273 K
Calculated Reported
Volume 2100.3(6) 2100.3(5)
Space group P 21/c P 1 21/c 1
Hall group -P 2ybc -P 2ybc
Moiety formula C_{22} H_{25} N O_3 S C_{22} H_{25} N O_3 S
Sum formula C_{22} H_{25} N O_3 S C_{22} H_{25} N O_3 S
Mr 383.49 383.49
Dx,g cm-3 1.213 1.213
Z 4 4
Mu (mm-1) 0.175 0.175
F000 816.0 816.0
F000’ 816.84
h,k,lmax 10,21,19 10,21,19
Nref 4725 4678
Tmin,Tmax 0.924,0.932 0.551,0.746
Tmin’ 0.924
Correction method= # Reported T Limits: Tmin=0.551 Tmax=0.746
AbsCorr = NONE
Data completeness= 0.990 Theta(max)= 27.315
R(reflections)= 0.0507(4210) wR2(reflections)=
0.1310(4678)
S = 1.064 Npar= 247

8. Characterization Data of 3a – 3u, 4a – 4l.

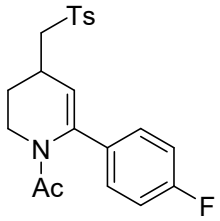
1-(6-phenyl-4-(tosylmethyl)-3,4-dihydropyridin-1(2H)-yl)ethan-1-one (3a)



White solid; mp 83.4-84.6 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.81 (d, *J* = 7.5 Hz, 2H), 7.38 (d, *J* = 7.5 Hz, 2H), 7.35 – 7.21 (m, 5H), 5.44 (s, 1H), 4.00 (s, 1H), 3.65 (t, *J* = 9.3 Hz, 1H), 3.21 (dd, *J* = 13.8, 6.3 Hz, 1H), 3.14 (dd, *J* = 13.6, 6.7 Hz, 1H), 3.05 (s, 1H), 2.13 (s, 1H), 1.73 (s, 1H), 1.60 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 171.1, 145.0, 141.9, 138.8, 136.7, 130.1, 128.8, 128.4, 128.0, 125.8, 118.6, 61.12, 42.1, 30.5, 30.03, 25.1, 21.7.

HRMS (ESI, m/z): Calcd. For $C_{21}H_{24}NO_3SNa$ $[M+Na]^+$ 392.1291, found: 392.1299.

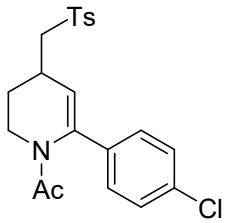
1-(6-(4-fluorophenyl)-4-(tosylmethyl)-3,4-dihydropyridin-1(2H)-yl)ethan-1-one (3b)



White solid; mp 84.0-84.8 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.81 (d, *J* = 8.1 Hz, 2H), 7.38 (d, *J* = 8.1 Hz, 2H), 7.26 (d, *J* = 5.3 Hz, 2H), 7.02 (t, *J* = 7.9 Hz, 2H), 5.43 (s, 1H), 4.00 (s, 1H), 3.63 (ddd, *J* = 12.4, 9.3, 3.0 Hz, 1H), 3.19 (dd, *J* = 14.0, 6.7 Hz, 1H), 3.13 (dd, *J* = 14.0, 6.7 Hz, 1H), 3.05 (dd, *J* = 10.3, 6.7 Hz, 1H), 2.46 (d, *J* = 7.9 Hz, 3H), 2.13 (s, 1H), 1.72 (s, 1H), 1.62 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 171.0, 162.7 (J_{C-F} = 257 Hz), 145.0, 140.9, 136.7, 134.9, 130.1, 127.9, 127.5, 118.5, 115.8 (J_{C-F} = 15 Hz), 61.1, 42.2, 30.5, 30.0, 25.1, 21.7. ^{19}F NMR (565 MHz, $CDCl_3$) δ -112.71.

HRMS (ESI, m/z): Calcd. For $C_{21}H_{23}NO_3FS$ $[M+H]^+$ 388.1377, found: 388.1372.

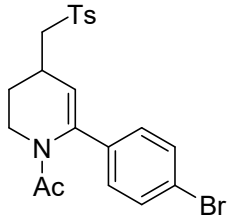
1-(6-(4-chlorophenyl)-4-(tosylmethyl)-3,4-dihydropyridin-1(2H)-yl)ethan-1-one (3c)



White solid; mp 91.2-92.4 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.81 (d, *J* = 7.8 Hz, 2H), 7.38 (d, *J* = 7.8 Hz, 2H), 7.30 (d, *J* = 6.5 Hz, 2H), 7.22 (s, 2H), 5.48 (s, 1H), 4.00 (s, 1H), 3.62 (t, *J* = 9.7 Hz, 1H), 3.19 (dd, *J* = 14.0, 6.7 Hz, 1H), 3.13 (dd, *J* = 14.0, 6.6 Hz, 1H), 3.06 (s, 1H), 2.47 (s, 3H), 2.13 (s, 1H), 1.73 (s, 1H), 1.62 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 170.9, 145.1, 140.9, 137.3, 136.69, 134.2, 130.1, 129.0, 127.9, 127.0, 119.1, 61.0, 42.110, 30.430, 30.0, 25.1, 21.7.

HRMS (ESI, m/z): Calcd. For $C_{21}H_{23}NO_3ClS$ $[M+H]^+$ 404.1082, found: 404.1085.

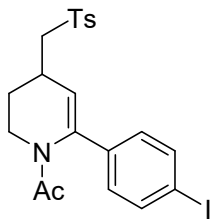
1-(6-(4-bromophenyl)-4-(tosylmethyl)-3,4-dihydropyridin-1(2H)-yl)ethan-1-one (3d)



White solid; mp 89.4-90.8 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.81 (d, *J* = 8.0 Hz, 2H), 7.46 (s, 2H), 7.38 (d, *J* = 7.9 Hz, 2H), 7.16 (s, 2H), 5.48 (s, 1H), 4.00 (s, 1H), 3.68 – 3.53 (m, 1H), 3.20 (dd, *J* = 14.0, 6.7 Hz, 1H), 3.13 (dd, *J* = 14.0, 6.7 Hz, 1H), 3.05 (s, 1H), 2.47 (s, 3H), 2.13 (s, 1H), 1.72 (s, 1H), 1.61 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 170.9, 145.1, 140.9, 137.7, 136.7, 132.0, 130.1, 127.9, 127.3, 122.3, 119.2, 60.9, 42.1, 30.4, 30.0, 25.1, 21.7.

HRMS (ESI, m/z): Calcd. For $C_{21}H_{22}NO_3BrSNa$ $[M+Na]^+$ 470.0396, found: 470.0401.

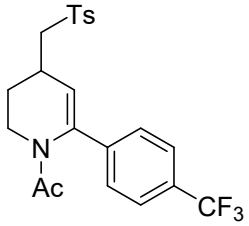
1-(6-(4-iodophenyl)-4-(tosylmethyl)-3,4-dihydropyridin-1(2H)-yl)ethan-1-one (3e)



White solid; mp 106.5-108.1 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.80 (d, *J* = 8.0 Hz, 2H), 7.65 (s, 2H), 7.37 (d, *J* = 7.8 Hz, 2H), 7.02 (s, 2H), 5.47 (s, 1H), 3.99 (s, 1H), 3.61 (t, *J* = 9.6 Hz, 1H), 3.20 (dd, *J* = 14.0, 6.7 Hz, 1H), 3.13 (dd, *J* = 13.9, 6.7 Hz, 1H), 3.04 (s, 1H), 2.46 (s, 3H), 2.11 (s, 1H), 1.81 (s, 1H), 1.61 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 170.97, 145.07, 141.03, 138.40, 137.93, 136.68, 130.13, 127.93, 127.46, 119.30, 93.94, 60.91, 42.18, 30.40, 30.04, 25.21, 21.70.

HRMS (ESI, m/z): Calcd. For $C_{21}H_{26}NIO_3S$ $[M+H]^+$ 496.0438, found: 496.0446.

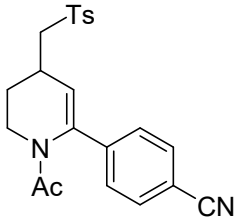
1-(4-(tosylmethyl)-6-(4-(trifluoromethyl)phenyl)-3,4-dihydropyridin-1(2H)-yl)ethan-1-one (3f)



Amorphous solid; ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.81 (d, *J* = 8.1 Hz, 2H), 7.59 (s, 2H), 7.38 (d, *J* = 8.0 Hz, 4H), 5.60 (s, 1H), 4.02 (s, 1H), 3.69 – 3.60 (m, 1H), 3.21 (dd, *J* = 13.9, 6.7 Hz, 1H), 3.15 (dd, *J* = 13.9, 6.6 Hz, 1H), 3.10 (s, 1H), 2.47 (s, 3H), 2.16 (s, 1H), 1.75 (s, 1H), 1.61 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 170.9, 145.1, 142.3, 140.8, 136.7, 130.2, 127.9, 125.9 (J_{C-F} = 3 Hz), 123.9 (J_{C-F} = 272 Hz), 120.8, 60.9, 42.2, 30.4, 30.1, 25.1, 21.7. ^{19}F NMR (565 MHz, $CDCl_3$) δ -62.6.

HRMS (ESI, m/z): Calcd. For $C_{22}H_{23}NF_3O_3S$ $[M+H]^+$ 438.1345, found: 438.1347.

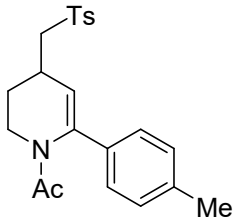
4-(1-acetyl-4-(tosylmethyl)-1,4,5,6-tetrahydropyridin-2-yl)benzonitrile (3g)



White solid; mp 82.7-83.6 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.81 (d, *J* = 7.4 Hz, 2H), 7.62 (s, 2H), 7.39 (d, *J* = 7.3 Hz, 4H), 5.68 (s, 1H), 4.03 (s, 1H), 3.62 (t, *J* = 10.1 Hz, 1H), 3.26 – 3.03 (m, 3H), 2.47 (s, 3H), 2.16 (s, 2H), 1.68 (d, *J* = 89.8 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 170.72, 145.18, 143.13, 140.49, 136.60, 132.53, 130.16,

127.90, 126.23, 121.81, 118.36, 111.98, 60.69, 42.22, 30.30, 30.08, 24.83, 21.67. HRMS (ESI, m/z): Calcd. For $C_{22}H_{22}N_2O_3SNa$ $[M+Na]^+$ 417.1243, found: 417.1250.

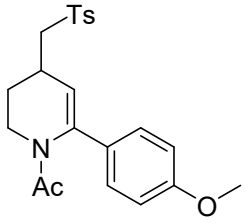
1-(6-(p-tolyl)-4-(tosylmethyl)-3,4-dihydropyridin-1(2H)-yl)ethan-1-one (3h)



White solid; mp 92.1-93.8 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.81 (d, *J* = 8.1 Hz, 2H), 7.38 (d, *J* = 7.9 Hz, 2H), 7.14 (d, *J* = 10.7 Hz, 4H), 5.39 (s, 1H), 3.98 (s, 1H), 3.71 – 3.59 (m, 1H), 3.20 (dd, *J* = 14.0, 6.5 Hz, 1H), 3.13 (dd, *J* = 14.0, 6.9 Hz, 1H), 3.03 (d, *J* = 3.5 Hz, 1H), 2.46 (s, 3H), 2.34 (s, 3H), 2.11 (s, 1H), 1.72 (s, 1H), 1.61 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 171.23, 144.97, 141.86, 138.38, 136.76, 135.96, 130.09, 129.48, 127.96, 125.65, 117.74, 61.19, 42.04, 30.54, 30.00, 25.13, 21.65, 21.18.

HRMS (ESI, m/z): Calcd. For $C_{22}H_{25}NO_3SNa$ $[M+Na]^+$ 406.1447, found: 406.1456.

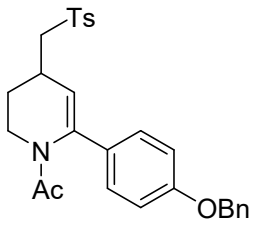
1-(6-(4-methoxyphenyl)-4-(tosylmethyl)-3,4-dihydropyridin-1(2H)-yl)ethan-1-one (3i)



White solid; mp 102.8-103.5 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.81 (d, *J* = 8.1 Hz, 2H), 7.38 (d, *J* = 8.0 Hz, 2H), 7.20 (d, *J* = 8.3 Hz, 2H), 6.85 (d, *J* = 8.5 Hz, 2H), 5.34 (s, 1H), 3.98 (s, 1H), 3.82 (d, *J* = 10.0 Hz, 3H), 3.63 (ddd, *J* = 12.3, 9.2, 3.0 Hz, 1H), 3.20 (dd, *J* = 14.0, 6.5 Hz, 1H), 3.13 (dd, *J* = 14.0, 6.9 Hz, 1H), 3.03 (dd, *J* = 6.7, 3.8 Hz, 1H), 2.46 (s, 3H), 2.11 (s, 1H), 1.72 (s, 1H), 1.62 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 171.27, 159.73, 144.95, 141.52, 136.77, 131.29, 130.08, 130.00, 127.94, 127.02, 116.95, 114.16, 61.23, 55.33, 42.11, 30.56, 29.95, 25.08, 21.65.

HRMS (ESI, m/z): Calcd. For $C_{22}H_{25}NO_4SNa$ $[M+Na]^+$ 422.1397, found: 422.1402.

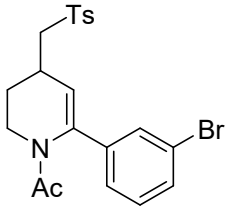
1-(6-(4-(benzyloxy)phenyl)-4-(tosylmethyl)-3,4-dihydropyridin-1(2H)-yl)ethan-1-one (3j)



White solid; mp 97.6-98.8 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.81 (d, *J* = 8.1 Hz, 2H), 7.42 (d, *J* = 7.4 Hz, 2H), 7.40 – 7.35 (m, 4H), 7.32 (s, 1H), 7.19 (d, *J* = 8.2 Hz, 2H), 6.93 (d, *J* = 8.5 Hz, 2H), 5.34 (s, 1H), 5.05 (s, 2H), 3.97 (s, 1H), 3.71 – 3.57 (m, 1H), 3.19 (dd, *J* = 14.0, 6.5 Hz, 1H), 3.12 (dd, *J* = 14.0, 6.8 Hz, 1H), 3.02 (dd, *J* = 10.4, 6.7 Hz, 1H), 2.45 (s, 3H), 2.10 (s, 1H), 1.70 (s, 1H), 1.63 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 171.27, 158.93, 144.96, 141.49, 136.77, 136.62, 131.55, 130.08, 128.62, 128.09, 127.95, 127.49, 127.04, 117.05, 115.11, 61.25, 42.08, 30.57, 29.96, 25.11, 21.65.

HRMS (ESI, m/z): Calcd. For $C_{28}H_{30}NO_4S$ $[M+H]^+$ 476.1890, found: 476.1889.

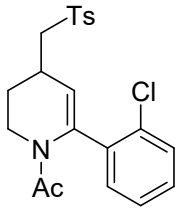
1-(6-(3-bromophenyl)-4-(tosylmethyl)-3,4-dihydropyridin-1(2H)-yl)ethan-1-one (3k)



White solid; mp 59.5-61.8 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.81 (d, *J* = 8.2 Hz, 2H), 7.40 (t, *J* = 11.4 Hz, 4H), 7.21 (s, 2H), 5.46 (s, 1H), 4.00 (s, 1H), 3.62 (ddd, *J* = 12.4, 9.3, 3.0 Hz, 1H), 3.20 (d0, *J* = 14.0, 6.7 Hz, 1H), 3.14 (dd, *J* = 14.0, 6.7 Hz, 1H), 3.06 (dd, *J* = 10.4, 6.7 Hz, 1H), 2.47 (s, 3H), 2.14 (s, 1H), 1.73 (s, 1H), 1.65 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 170.91, 145.11, 140.82, 140.58, 136.68, 131.38, 130.33, 130.14, 128.60, 127.94, 14.33, 123.00, 119.85, 77.25, 77.04, 76.83, 60.94, 42.17, 30.43, 30.07, 25.19, 21.69.

HRMS (ESI, m/z): Calcd. For $C_{21}H_{23}NO_3BrS$ $[M+H]^+$ 448.0577, found: 448.0575.

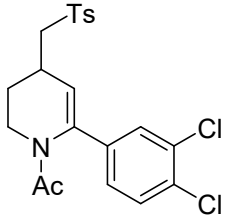
1-(6-(2-chlorophenyl)-4-(tosylmethyl)-3,4-dihydropyridin-1(2H)-yl)ethan-1-one (3l)



White solid; mp 75.6-76.9 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.88 – 7.74 (m, 2H), 7.37 (d, *J* = 7.8 Hz, 2H), 7.33 (s, 1H), 7.25 (s, 3H), 5.29 (s, 1H), 4.02 (s, 1H), 3.65 (s, 1H), 3.21 (dd, *J* = 14.0, 6.1 Hz, 1H), 3.15 (dd, *J* = 14.0, 7.2 Hz, 1H), 3.05 (s, 1H), 2.46 (d, *J* = 5.0 Hz, 3H), 2.18 (s, 1H), 1.80 (s, 1H), 1.55 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 169.46, 144.99, 138.80, 137.52, 136.68, 132.18, 130.09, 129.46, 127.91, 127.16, 120.53, 60.91, 41.20, 29.84, 24.50, 21.64.

HRMS (ESI, m/z): Calcd. For $C_{21}H_{23}NO_3ClS$ $[M+H]^+$ 404.1082, found: 404.1083.

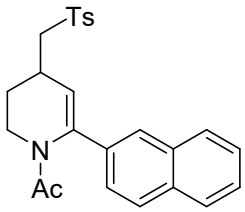
1-(6-(3,4-dichlorophenyl)-4-(tosylmethyl)-3,4-dihydropyridin-1(2H)-yl)ethan-1-one (3m)



Amorphous solid; ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.81 (d, *J* = 8.2 Hz, 2H), 7.37 (dd, *J* = 18.1, 8.4 Hz, 4H), 7.11 (d, *J* = 16.3 Hz, 1H), 5.50 (s, 1H), 3.99 (s, 1H), 3.60 (ddd, *J* = 12.6, 9.4, 3.0 Hz, 1H), 3.20 (dd, *J* = 14.0, 6.8 Hz, 1H), 3.14 (dd, *J* = 14.0, 6.6 Hz, 1H), 3.07 (d, *J* = 3.4 Hz, 1H), 2.47 (s, 3H), 2.14 (s, 1H), 1.75 (s, 1H), 1.65 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 170.88, 145.16, 139.90, 138.75, 136.66, 133.24, 132.37, 130.78, 130.16, 127.93, 127.38, 124.88, 120.24, 60.83, 42.19, 30.38, 30.05, 25.12, 21.68.

HRMS (ESI, m/z): Calcd. For $C_{21}H_{21}NO_3Cl_2SNa$ $[M+Na]^+$ 460.0511, found: 460.0517.

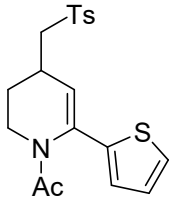
1-(6-(naphthalen-2-yl)-4-(tosylmethyl)-3,4-dihydropyridin-1(2H)-yl)ethan-1-one (3n)



White solid; mp 99.4-101.1 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.83 (d, *J* = 7.8 Hz, 2H), 7.80 (d, *J* = 8.8 Hz, 3H), 7.75 (s, 1H), 7.49 (s, 2H), 7.38 (d, *J* = 7.8 Hz, 3H), 5.59 (s, 1H), 4.07 (s, 1H), 3.71 (t, *J* = 9.6 Hz, 1H), 3.25 (dd, *J* = 14.0, 6.5 Hz, 1H), 3.17 (dd, *J* = 14.0, 6.8 Hz, 1H), 3.10 (d, *J* = 3.5 Hz, 1H), 2.46 (s, 3H), 2.17 (s, 1H), 1.77 (s, 1H), 1.64 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 171.31, 145.02, 141.93, 136.76, 136.15, 133.31, 133.15, 130.11, 128.67, 128.11, 127.97, 127.71, 126.67, 126.48, 124.67, 123.65, 119.30, 61.14, 42.16, 30.58, 30.18, 25.17, 21.66.

HRMS (ESI, m/z): Calcd. For $C_{25}H_{25}NO_3SNa$ $[M+Na]^+$ 442.1447, found: 442.1450.

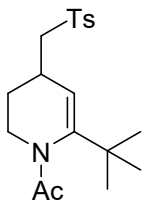
1-(6-(thiophen-2-yl)-4-(tosylmethyl)-3,4-dihydropyridin-1(2H)-yl)ethan-1-one (3o)



White solid; mp 64.9-66.4 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.81 (d, *J* = 8.1 Hz, 2H), 7.38 (d, *J* = 8.1 Hz, 2H), 7.23 (d, *J* = 4.7 Hz, 1H), 6.97 (dd, *J* = 11.5, 7.0 Hz, 2H), 5.51 (d, *J* = 3.4 Hz, 1H), 3.92 (d, *J* = 4.1 Hz, 1H), 3.73 – 3.57 (m, 1H), 3.20 (dd, *J* = 14.0, 6.2 Hz, 1H), 3.12 (dd, *J* = 14.0, 7.1 Hz, 1H), 3.08 – 2.99 (m, 1H), 2.12 (s, 1H), 1.81 (s, 3H), 1.73 (s, 1H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 171.41, 145.03, 141.87, 136.65, 136.19, 130.10, 127.93, 127.42, 125.39, 124.52, 118.02, 60.97, 42.21, 30.48, 29.90, 24.25, 21.65.

HRMS (ESI, m/z): Calcd. For $C_{19}H_{22}NO_3S$ $[M+H]^+$ 376.1036, found: 376.1034.

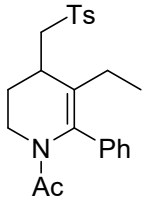
1-(6-(tert-butyl)-4-(tosylmethyl)-3,4-dihydropyridin-1(2H)-yl)ethan-1-one (3p)



Amorphous solid; ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.77 (d, *J* = 7.7 Hz, 2H), 7.36 (d, *J* = 7.8 Hz, 2H), 5.31 (s, 1H), 3.14 (dd, *J* = 13.7, 5.5 Hz, 1H), 3.07 – 2.98 (m, 1H), 2.45 (s, 3H), 2.19 (s, 1H), 2.09 (s, 3H), 1.67 (s, 1H), 1.10 (s, 9H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 172.15, 154.41, 144.93, 136.67, 130.03, 127.96, 118.18, 61.66, 47.25, 37.04, 31.07, 30.38, 29.01, 22.80, 21.63.

HRMS (ESI, m/z): Calcd. For $C_{19}H_{28}NO_3S$ $[M+H]^+$ 350.1784, found: 350.1786.

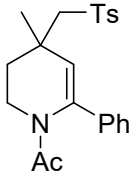
1-(5-ethyl-6-phenyl-4-(tosylmethyl)-3,4-dihydropyridin-1(2H)-yl)ethan-1-one (3q)



Amorphous solid; ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.81 (d, *J* = 7.7 Hz, 2H), 7.38 (d, *J* = 7.7 Hz, 2H), 7.33 (t, *J* = 7.1 Hz, 2H), 7.28 (d, *J* = 7.4 Hz, 1H), 7.17 (d, *J* = 7.8 Hz, 2H), 4.30 (s, 1H), 3.25 (s, 1H), 3.20 (dd, *J* = 14.0, 3.9 Hz, 1H), 3.13 (dd, *J* = 14.0, 8.9 Hz, 1H), 3.05 (d, *J* = 2.5 Hz, 1H), 2.47 (s, 3H), 2.32 (dd, *J* = 13.8, 6.9 Hz, 1H), 2.13 (dd, *J* = 12.1, 5.8 Hz, 2H), 2.07 – 1.97 (m, 1H), 1.51 (s, 3H), 0.89 (t, *J* = 6.7 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 170.83, 144.95, 137.84, 136.90, 136.42, 133.10, 130.08, 128.59, 128.44, 127.92, 127.84, 58.70, 41.49, 31.89, 30.29, 24.61, 24.54, 21.66, 12.86.

HRMS (ESI, m/z): Calcd. For $C_{23}H_{28}NO_3S$ $[M+H]^+$ 398.1784, found: 398.1786.

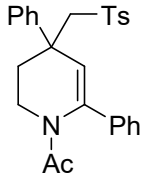
1-(4-methyl-6-phenyl-4-(tosylmethyl)-3,4-dihydropyridin-1(2H)-yl)ethan-1-one (3r)



White solid; mp 88.8-89.5 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.78 (d, *J* = 8.2 Hz, 2H), 7.32 (t, *J* = 8.2 Hz, 7H), 5.40 (s, 1H), 4.40 (s, 1H), 3.34 (s, 1H), 2.43 (s, 3H), 2.25 (ddd, *J* = 13.9, 10.4, 3.8 Hz, 1H), 1.78 (s, 1H), 1.63 (s, 3H), 1.35 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 171.44, 144.62, 139.93, 138.99, 138.49, 129.96, 128.75, 128.28, 127.65, 125.97, 123.27, 65.95, 41.10, 36.60, 36.02, 28.56, 25.13, 21.61.

HRMS (ESI, m/z): Calcd. For $C_{22}H_{26}NO_3S$ $[M+H]^+$ 384.1628, found: 384.1633.

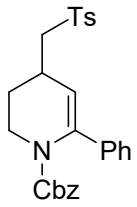
1-(4,6-diphenyl-4-(tosylmethyl)-3,4-dihydropyridin-1(2H)-yl)ethan-1-one (3s)



White solid; mp 103.3-104.6 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.60 (d, *J* = 8.1 Hz, 2H), 7.48 (s, 2H), 7.39 (t, *J* = 7.3 Hz, 2H), 7.36 (d, *J* = 7.1 Hz, 1H), 7.21 (dd, *J* = 7.9, 5.8 Hz, 6H), 7.18 (dd, *J* = 6.2, 2.2 Hz, 1H), 5.99 (s, 1H), 4.29 (s, 1H), 3.69 (s, 2H), 3.22 (t, *J* = 10.8 Hz, 1H), 2.61 (t, *J* = 10.4 Hz, 1H), 2.39 (s, 3H), 2.19 (d, *J* = 13.5 Hz, 1H), 1.66 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 171.79, 144.72, 144.37, 141.53, 139.17, 138.14, 129.79, 128.86, 128.60, 128.45, 127.65, 127.01, 126.42, 126.26, 120.03, 65.94, 42.71, 40.79, 37.98, 25.27, 21.56.

HRMS (ESI, m/z): Calcd. For $C_{27}H_{28}NO_3S$ $[M+H]^+$ 446.1784, found: 446.1788.

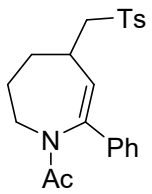
benzyl 6-phenyl-4-(tosylmethyl)-3,4-dihydropyridine-1(2H)-carboxylate (3t)



White solid; mp 84.5-85.7 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.79 (d, *J* = 8.2 Hz, 2H), 7.35 (d, *J* = 8.0 Hz, 2H), 7.28 – 7.23 (m, 3H), 7.23 – 7.18 (m, 3H), 7.16 (t, *J* = 7.0 Hz, 2H), 6.77 (s, 2H), 5.22 (d, *J* = 3.4 Hz, 1H), 4.89 (s, 2H), 3.94 (ddd, *J* = 12.8, 6.3, 3.2 Hz, 1H), 3.67 – 3.55 (m, 1H), 3.18 (dd, *J* = 14.1, 5.9 Hz, 1H), 3.11 (dd, *J* = 14.1, 7.4 Hz, 1H), 3.07 – 2.98 (m, 1H), 2.44 (s, 3H), 2.14 (dd, *J* = 6.8, 2.6 Hz, 1H), 1.87 – 1.72 (m, 1H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 154.60, 144.93, 141.23, 139.05, 136.82, 135.48, 130.09, 128.20, 127.97, 127.84, 127.71, 125.40, 116.17, 67.74, 61.09, 44.00, 29.90, 29.84, 21.66.

HRMS (ESI, m/z): Calcd. For $C_{27}H_{28}NO_4S$ $[M+H]^+$ 462.1734, found: 462.1735.

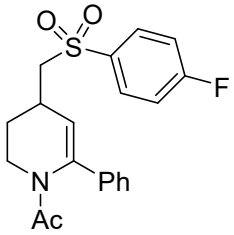
1-(7-phenyl-5-(tosylmethyl)-2,3,4,5-tetrahydro-1H-azepin-1-yl)ethan-1-one (3u)



White solid; mp 83.9-85.2 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.80 (d, *J* = 8.1 Hz, 2H), 7.38 (d, *J* = 8.1 Hz, 2H), 7.36 – 7.31 (m, 3H), 7.26 (d, *J* = 7.0 Hz, 2H), 6.11 (d, *J* = 5.0 Hz, 1H), 4.64 (d, *J* = 13.1 Hz, 1H), 3.44 – 3.33 (m, 1H), 3.18 (dd, *J* = 14.2, 2.6 Hz, 1H), 2.86 (s, 1H), 2.61 (t, *J* = 12.4 Hz, 1H), 2.47 (s, 3H), 1.93 (d, *J* = 12.5 Hz, 1H), 1.81 (d, *J* = 13.6 Hz, 1H), 1.69 (d, *J* = 10.1 Hz, 4H), 1.37 (d, *J* = 11.5 Hz, 1H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 170.25, 145.17, 143.27, 136.43, 136.16, 130.11, 128.93, 128.69, 128.14, 127.87, 124.80, 62.02, 45.13, 34.36, 31.03, 28.23, 22.46, 21.67.

HRMS (ESI, m/z): Calcd. For $C_{22}H_{26}NO_3S$ $[M+H]^+$ 384.1628, found: 384.1625.

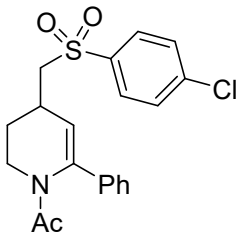
1-(4-(((4-fluorophenyl)sulfonyl)methyl)-6-phenyl-3,4-dihydropyridin-1(2H)-yl)ethan-1-one (4a)



White solid; mp 77.6-79.9 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.96 (dd, *J* = 8.2, 5.1 Hz, 2H), 7.41 – 7.19 (m, 7H), 5.45 (s, 1H), 4.01 (s, 1H), 3.67 (t, *J* = 9.6 Hz, 1H), 3.22 (dd, *J* = 13.9, 6.5 Hz, 1H), 3.16 (dd, *J* = 13.9, 6.9 Hz, 1H), 3.08 (d, *J* = 3.3 Hz, 1H), 2.16 (s, 1H), 1.77 (s, 1H), 1.61 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 171.12, 165.92 (J_{C-F} = 257 Hz), 142.12, 138.76, 135.80 (J_{C-F} = 3 Hz), 130.82 (J_{C-F} = 9 Hz), 128.86, 128.49, 125.76, 118.18, 116.84 (J_{C-F} = 23 Hz), 61.20, 42.01, 30.49, 29.93, 25.10. ^{19}F NMR (565 MHz, $CDCl_3$) δ -102.89.

HRMS (ESI, m/z): Calcd. For $C_{20}H_{20}NO_3SFNa$ $[M+Na]^+$ 396.1040, found: 396.1050.

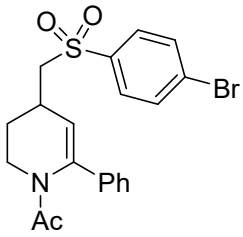
1-(4-(((4-chlorophenyl)sulfonyl)methyl)-6-phenyl-3,4-dihydropyridin-1(2H)-yl)ethan-1-one (4b)



White solid; mp 112.2-113.3 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.87 (d, *J* = 5.5 Hz, 2H), 7.56 (s, 2H), 7.30 (d, *J* = 36.0 Hz, 5H), 5.42 (s, 1H), 4.01 (s, 1H), 3.66 (s, 1H), 3.22 (dd, *J* = 13.9, 6.5 Hz, 1H), 3.15 (dd, *J* = 13.7, 6.8 Hz, 1H), 3.07 (s, 1H), 2.15 (s, 1H), 1.76 (s, 1H), 1.61 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 171.12, 142.15, 140.76, 138.73, 138.17, 129.84, 129.43, 128.86, 128.49, 125.75, 118.09, 61.09, 42.05, 30.49, 29.92, 25.08.

HRMS (ESI, m/z): Calcd. For $C_{20}H_{20}NO_3SClNa$ $[M+Na]^+$ 412.0745, found: 412.0755.

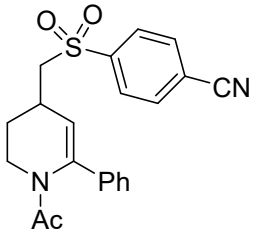
1-(4-(((4-bromophenyl)sulfonyl)methyl)-6-phenyl-3,4-dihydropyridin-1(2H)-yl)ethan-1-one (4c)



White solid; mp 120.4-121.7 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.80 (d, *J* = 8.1 Hz, 2H), 7.73 (d, *J* = 8.1 Hz, 2H), 7.44 – 7.25 (m, 5H), 5.42 (s, 1H), 4.02 (s, 1H), 3.66 (t, *J* = 9.6 Hz, 1H), 2.15 (s, 1H), 1.76 (s, 1H), 1.61 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 171.09, 142.13, 138.68, 132.82, 129.47, 129.31, 128.85, 128.48, 125.73, 118.06, 61.03, 42.01, 30.47, 29.91, 25.09.

HRMS (ESI, m/z): Calcd. For $C_{20}H_{21}NO_3SBr$ $[M+H]^+$ 434.0420, found: 434.0417.

4-(((1-acetyl-6-phenyl-1,2,3,4-tetrahydropyridin-4-yl)methyl)sulfonyl)benzonitrile (4d)

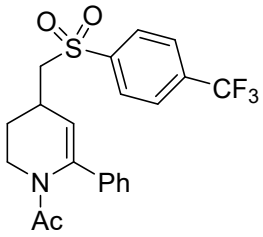


White solid; mp 98.7-99.9 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.08 (d, *J* = 7.3 Hz, 2H),

7.89 (d, J = 7.0 Hz, 2H), 7.33 (s, 3H), 7.28 (s, 2H), 5.42 (s, 1H), 4.03 (s, 1H), 3.68 (s, 1H), 3.26 (dd, J = 13.8, 6.4 Hz, 1H), 3.19 (dd, J = 13.7, 6.9 Hz, 1H), 3.12 (s, 1H), 2.18 (s, 1H), 1.79 (s, 1H), 1.61 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 171.09, 143.78, 142.43, 138.64, 133.26, 128.89, 128.76, 128.68, 125.74, 117.75, 117.58, 116.97, 60.84, 41.94, 30.44, 29.78, 25.14.

HRMS (ESI, m/z): Calcd. For $C_{21}H_{20}N_2O_3SNa$ $[M+Na]^+$ 403.1087, found: 403.1092.

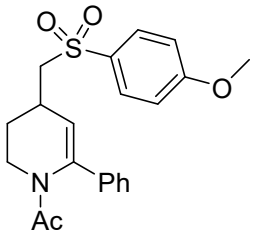
1-(6-phenyl-4-(((4-(trifluoromethyl)phenyl)sulfonyl)methyl)-3,4-dihydropyridin-1(2H)-yl)ethan-1-one (4e)



White solid; mp 65.3-66.8 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.09 (d, J = 8.0 Hz, 2H), 7.87 (d, J = 8.0 Hz, 2H), 7.33 (d, J = 7.2 Hz, 3H), 7.27 (b, 2H), 5.42 (s, 1H), 4.04 (s, 1H), 3.67 (t, J = 10.4 Hz, 1H), 3.26 (dd, J = 14.0, 6.6 Hz, 1H), 3.20 (dd, J = 14.0, 6.7 Hz, 1H), 3.12 (d, J = 3.2 Hz, 1H), 2.18 (s, 1H), 1.88 – 1.72 (m, 2H), 1.61 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 171.18, 143.25, 142.35, 138.69, 135.70 (J_{C-F} = 33 Hz), 128.89, 128.63, 128.57, 126.69 (J_{C-F} = 3.0 Hz), 125.77, 123.06 (J_{C-F} = 273 Hz), 117.84, 60.97, 42.06, 30.50, 29.87, 25.11. ^{19}F NMR (565 MHz, $CDCl_3$) δ -63.18.

HRMS (ESI, m/z): Calcd. For $C_{21}H_{21}NO_3SF_3Na$ $[M+Na]^+$ 446.1008, found: 446.1002.

1-(4-(((4-methoxyphenyl)sulfonyl)methyl)-6-phenyl-3,4-dihydropyridin-1(2H)-yl)ethan-1-one (4f)

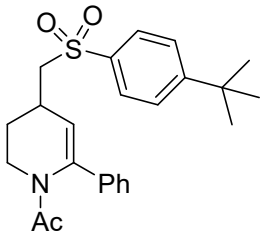


White solid; mp 107.8-108.5 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.86 (d, J = 8.4 Hz, 2H), 7.38 – 7.27 (m, 5H), 7.04 (d, J = 8.4 Hz, 2H), 5.45 (s, 1H), 4.00 (s, 1H), 3.66 (s, 1H), 3.20 (dd, J = 13.9, 6.4 Hz, 1H), 3.16 – 3.10 (m, 1H), 3.04 (s, 1H), 2.12 (s, 1H), 1.73 (s, 1H), 1.60 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 171.17, 163.93, 141.85,

138.85, 131.20, 130.14, 128.84, 128.41, 125.76, 118.70, 114.67, 61.35, 55.76, 42.08, 30.51, 30.11, 25.10.

HRMS (ESI, m/z): Calcd. For $C_{21}H_{22}NO_4SNa$ $[M+Na]^+$ 408.1240, found: 408.1239.

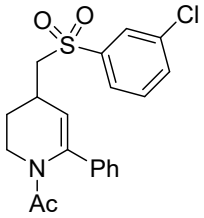
1-(4-(((4-(tert-butyl)phenyl)sulfonyl)methyl)-6-phenyl-3,4-dihydropyridin-1(2H)-yl)ethan-1-one (4g)



White solid; mp 89.0-89.8 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.85 (dd, *J* = 8.2, 3.1 Hz, 2H), 7.62 – 7.57 (m, 2H), 7.29 (d, *J* = 25.8 Hz, 5H), 5.45 (s, 1H), 4.01 (s, 1H), 3.66 (s, 1H), 3.22 (dd, *J* = 14.0, 6.7 Hz, 1H), 3.15 (dd, J = 13.9, 6.6 Hz, 1H), 3.07 (s, 1H), 2.15 (s, 1H), 1.76 (s, 1H), 1.60 (s, 3H), 1.35 (s, 9H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 171.14, 157.96, 141.85, 138.84, 136.67, 128.83, 128.40, 127.80, 126.50, 125.74, 118.69, 61.06, 42.10, 35.32, 31.07, 30.56, 30.01, 25.10.

HRMS (ESI, m/z): Calcd. For $C_{24}H_{29}NO_3S$ $[M+H]^+$ 412.1941, found: 412.1944.

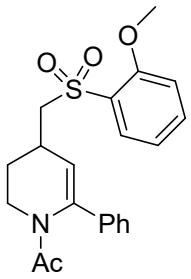
1-(4-(((3-chlorophenyl)sulfonyl)methyl)-6-phenyl-3,4-dihydropyridin-1(2H)-yl)ethan-1-one (4h)



Amorphous solid; ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.94 (s, 1H), 7.83 (d, *J* = 7.8 Hz, 1H), 7.65 (d, *J* = 8.0 Hz, 1H), 7.54 (t, *J* = 7.9 Hz, 1H), 7.38 – 7.26 (m, 5H), 5.46 (s, 1H), 4.02 (s, 1H), 3.75 – 3.61 (m, 1H), 3.24 (dd, *J* = 13.9, 6.5 Hz, 1H), 3.17 (dd, *J* = 13.9, 6.9 Hz, 1H), 3.10 (dd, *J* = 10.3, 6.6 Hz, 1H), 2.17 (s, 1H), 1.78 (s, 1H), 1.61 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 171.11, 142.20, 141.45, 138.72, 135.77, 134.10, 130.84, 128.85, 128.49, 128.01, 126.02, 125.75, 118.05, 60.99, 42.01, 30.48, 29.85, 25.08.

HRMS (ESI, m/z): Calcd. For $C_{20}H_{20}NO_3SClNa$ $[M+Na]^+$ 412.0745, found: 412.0750.

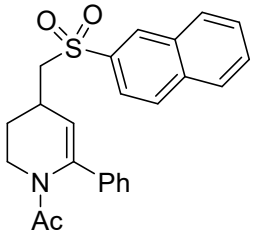
1-(4-(((2-methoxyphenyl)sulfonyl)methyl)-6-phenyl-3,4-dihydropyridin-1(2H)-yl)ethan-1-one (4i)



White solid; mp 69.5-70.8 °C; ; ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.98 (dd, *J* = 7.8, 1.4 Hz, 1H), 7.61 (d, *J* = 7.3 Hz, 1H), 7.37 – 7.29 (m, 3H), 7.27 (s, 2H), 7.12 (t, *J* = 7.5 Hz, 1H), 7.07 (d, *J* = 8.3 Hz, 1H), 5.43 (s, 1H), 3.99 (s, 1H), 4.00 (s, 3H), 3.68 – 3.58 (m, 1H), 3.51 – 3.38 (m, 2H), 3.07 (d, *J* = 3.4 Hz, 1H), 2.10 (s, 1H), 1.77 (s, 1H), 1.60 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 171.21, 157.29, 141.73, 138.89, 135.83, 130.29, 128.82, 128.36, 127.57, 125.74, 121.01, 119.02, 112.55, 59.19, 56.46, 42.13, 30.41, 30.02, 25.12.

HRMS (ESI, m/z): Calcd. For $C_{21}H_{23}NO_4S$ $[M+H]^+$ 386.1421, found: 386.1424.

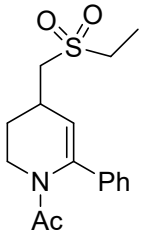
1-(4-((naphthalen-2-ylsulfonyl)methyl)-6-phenyl-3,4-dihydropyridin-1(2H)-yl)ethan-1-one (4j)



White solid; mp 82.4-83.7 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.52 (s, 1H), 8.01 (dd, *J* = 16.0, 8.4 Hz, 2H), 7.95 (d, *J* = 8.0 Hz, 1H), 7.89 (d, *J* = 8.5 Hz, 1H), 7.69 (d, *J* = 7.7 Hz, 1H), 7.65 (d, *J* = 7.4 Hz, 1H), 7.27 (d, *J* = 5.2 Hz, 3H), 7.22 (s, 2H), 5.45 (s, 1H), 4.00 (s, 1H), 3.64 (t, *J* = 9.9 Hz, 1H), 3.31 (dd, *J* = 14.0, 6.5 Hz, 1H), 3.25 (dd, *J* = 14.0, 6.6 Hz, 1H), 3.10 (d, *J* = 3.2 Hz, 1H), 2.15 (s, 1H), 1.78 (s, 1H), 1.59 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 171.14, 141.96, 138.76, 136.52, 135.39, 132.23, 129.90, 129.82, 129.51, 129.46, 128.82, 128.41, 128.07, 127.94, 125.73, 122.49, 118.53, 61.06, 42.10, 30.56, 30.07, 25.11.

HRMS (ESI, m/z): Calcd. For $C_{24}H_{24}NO_3S$ $[M+H]^+$ 406.1471, found: 406.1470.

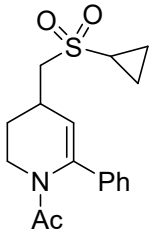
1-(4-((ethylsulfonyl)methyl)-6-phenyl-3,4-dihydropyridin-1(2H)-yl)ethan-1-one (4k)



White solid; mp 96.2-97.3 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.34 (s, 5H), 5.53 (s, 1H), 4.05 (s, 1H), 3.72 (t, *J* = 10.3 Hz, 1H), 3.22 (d, *J* = 3.1 Hz, 1H), 3.12 – 2.97 (m, 4H), 2.25 (s, 1H), 1.85 (s, 1H), 1.63 (s, 3H), 1.43 (t, *J* = 7.3 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 171.19, 142.15, 138.82, 128.87, 128.47, 125.81, 118.43, 56.32, 48.81, 42.06, 30.66, 29.08, 25.16, 6.75.

HRMS (ESI, m/z): Calcd. For $C_{16}H_{21}NO_3S$ $[M+H]^+$ 308.1315, found: 308.1319.

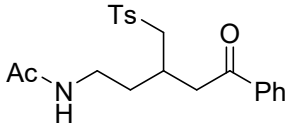
1-(4-((cyclopropylsulfonyl)methyl)-6-phenyl-3,4-dihydropyridin-1(2H)-yl)ethan-1-one (4l)



White solid; mp 68.2-69.4 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.33 (d, *J* = 10.8 Hz, 5H), 5.55 (s, 1H), 4.04 (s, 1H), 3.73 (dd, *J* = 15.1, 6.0 Hz, 1H), 3.25 – 3.16 (m, 2H), 3.12 (dd, *J* = 13.3, 7.0 Hz, 1H), 2.47 – 2.39 (m, 1H), 2.24 (s, 1H), 1.85 (s, 1H), 1.63 (s, 3H), 1.31 – 1.22 (m, 2H), 1.08 (dd, *J* = 7.8, 1.8 Hz, 2H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 171.20, 142.02, 138.85, 128.87, 128.44, 125.79, 118.63, 58.41, 42.07, 30.64, 30.54, 29.41, 25.13, 4.93, 4.91.

HRMS (ESI, m/z): Calcd. For $C_{17}H_{21}NO_3S$ $[M+H]^+$ 342.1134, found: 342.1144.

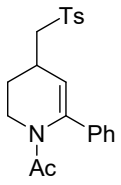
***N*-(5-oxo-5-phenyl-3-(tosylmethyl)pentyl)acetamide (4aa)**



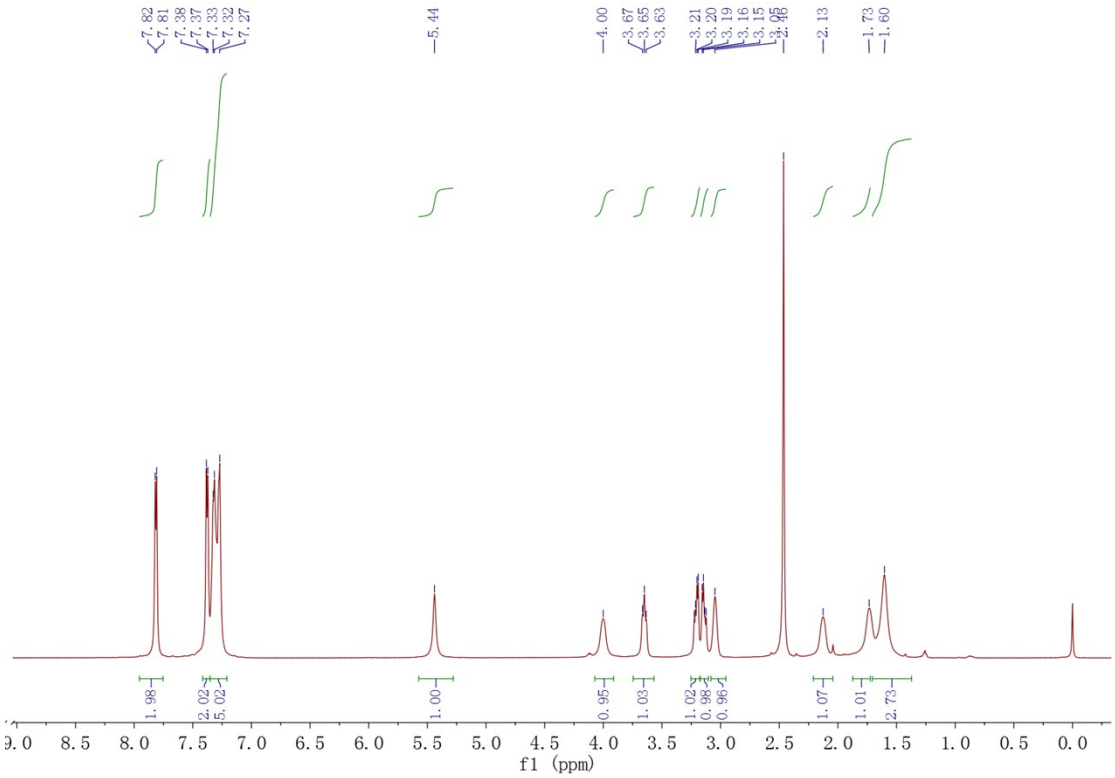
Amorphous solid; ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.92 (dd, *J* = 4.4, 2.9 Hz, 2H), 7.77 (d, *J* = 8.2 Hz, 2H), 7.57 (t, *J* = 7.3 Hz, 1H), 7.46 (dd, *J* = 9.3, 6.2 Hz, 2H), 7.34 (d, *J* = 8.1 Hz, 2H), 5.99 (s, 1H), 3.47 (dd, *J* = 17.9, 4.8 Hz, 1H), 3.33 – 3.25 (m, 2H), 3.22 (dd, *J* = 14.3, 4.8 Hz, 2H), 3.16 (dd, *J* = 17.9, 7.1 Hz, 1H), 2.72 (s, 1H), 2.42 (d, *J* = 2.6 Hz, 3H), 1.95 (t, *J* = 3.4 Hz, 3H), 1.77 (ddt, *J* = 27.5, 13.9, 7.1 Hz, 2H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 198.77, 170.30, 144.88, 136.65, 136.55, 133.48, 130.01, 128.70, 128.06, 127.88, 59.00, 41.81, 36.65, 33.52, 27.20, 23.25, 21.63.

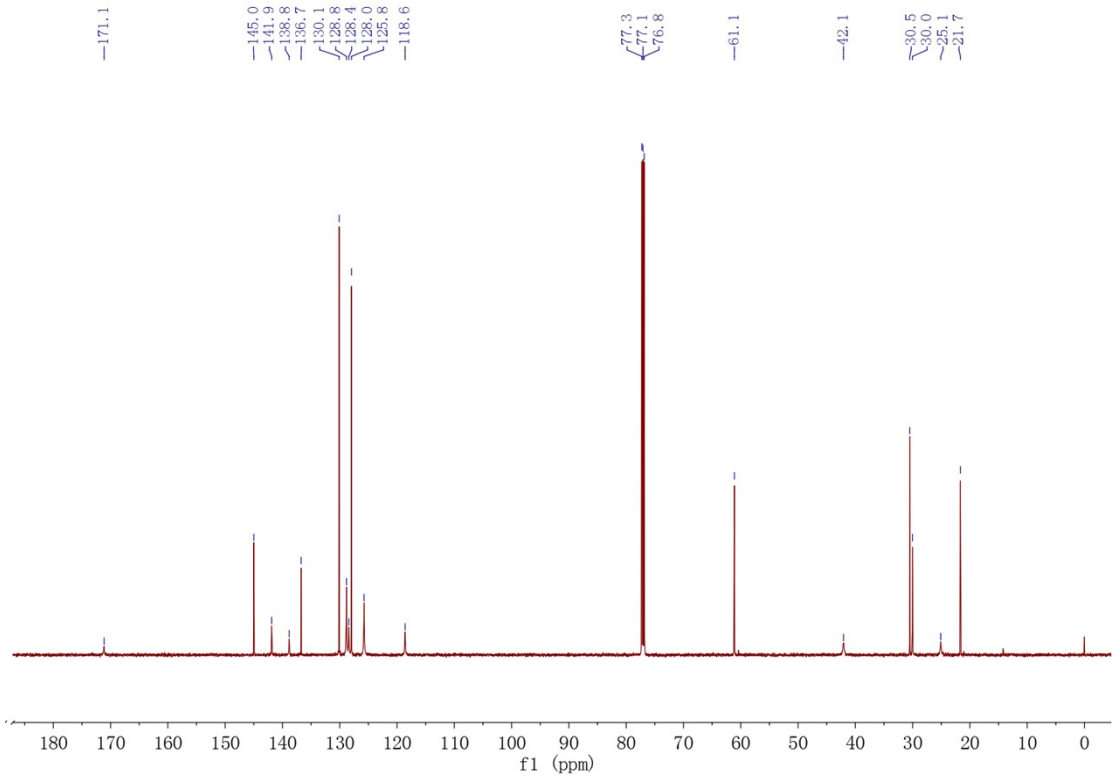
HRMS (ESI, m/z): Calcd. For $C_{21}H_{25}NO_4S$ $[M+H]^+$ 388.1577, found: 388.1587.

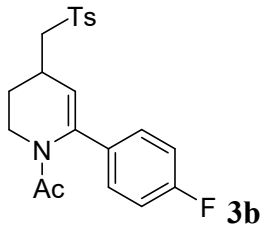
9. NMR spectra for the products



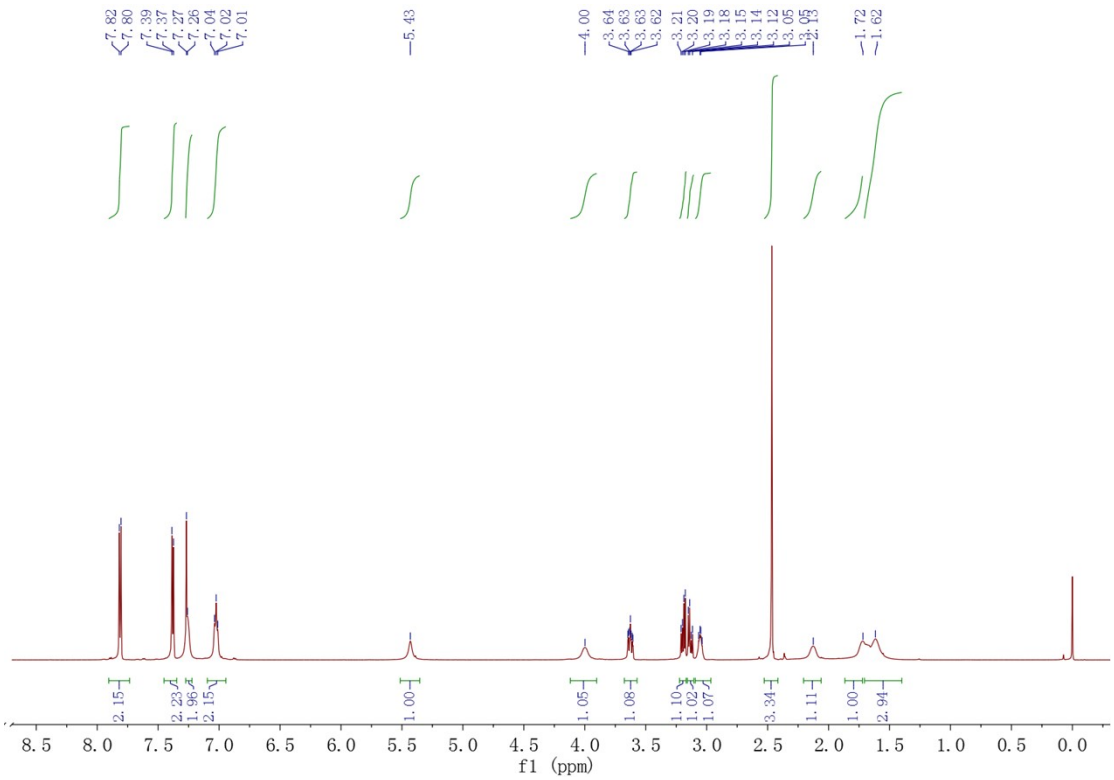
3a


7.82
7.81
7.38
7.37
7.33
7.32
7.27
5.44
4.00
3.67
3.65
3.63
3.21
3.20
3.19
3.16
3.15
2.13
1.73
1.60
1.98
2.02
5.02
1.00
0.95
1.03
1.02
0.98
0.96
1.07
1.01
2.73
f1 (ppm)


171.1
145.0
141.9
138.8
136.7
130.1
128.8
128.4
128.0
125.8
118.6
77.3
77.1
76.8
61.1
42.1
30.5
30.0
25.1
21.7
f1 (ppm)


Ts
N
Ac
F

3b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7.80
7.39
7.37
7.27
7.26
7.04
7.02
7.01
5.43
4.00
3.64
3.63
3.63
3.62
3.21
3.20
3.19
3.18
3.15
3.14
3.12
3.05
2.15
1.72
1.62
2.15
2.23
1.96
2.15
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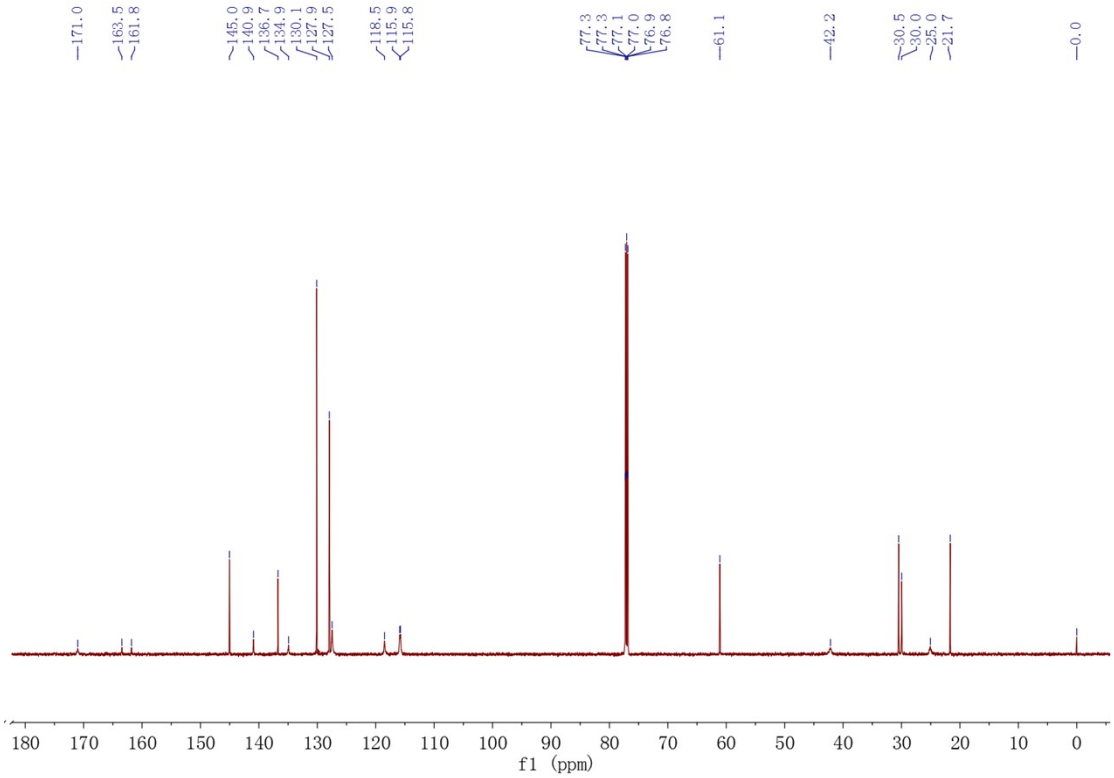
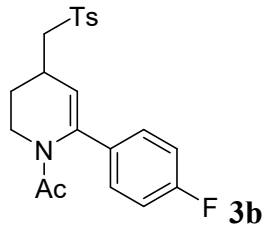
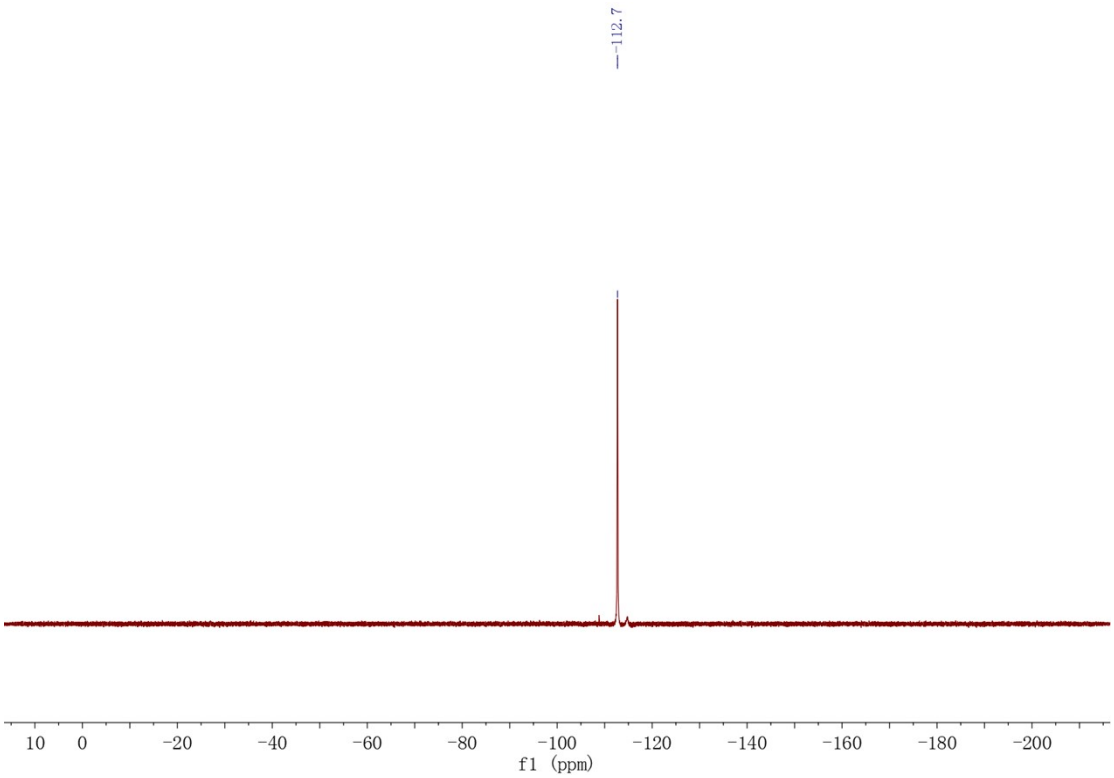
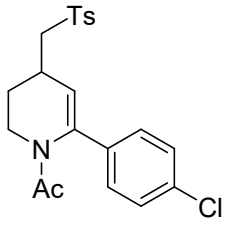
3.34
1.11
1.00
2.94
f1 (ppm)


171.0
163.5
161.8
145.0
140.9
136.7
134.9
130.1
127.9
127.5
118.5
115.9
115.8
77.3
77.3
77.1
77.0
76.9
76.8
61.1
42.2
30.5
30.0
25.0
21.7
0.0
f1 (ppm)

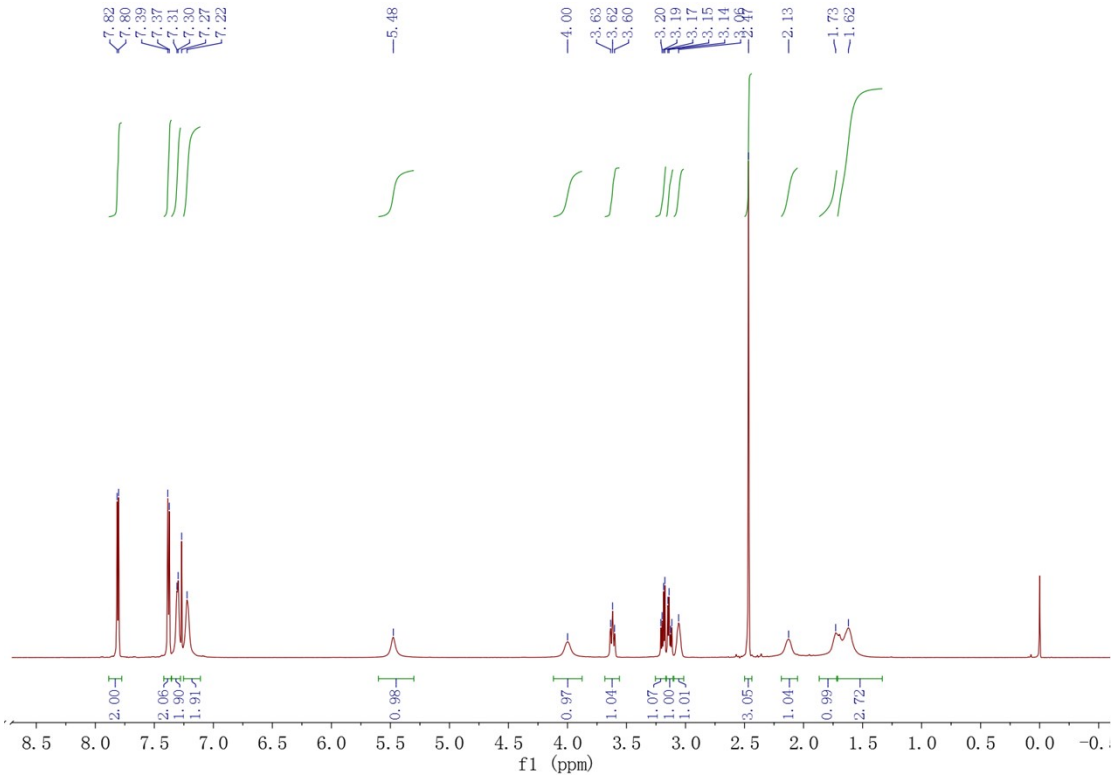

Ts
N
Ac
F

3b





3c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7.27
7.22
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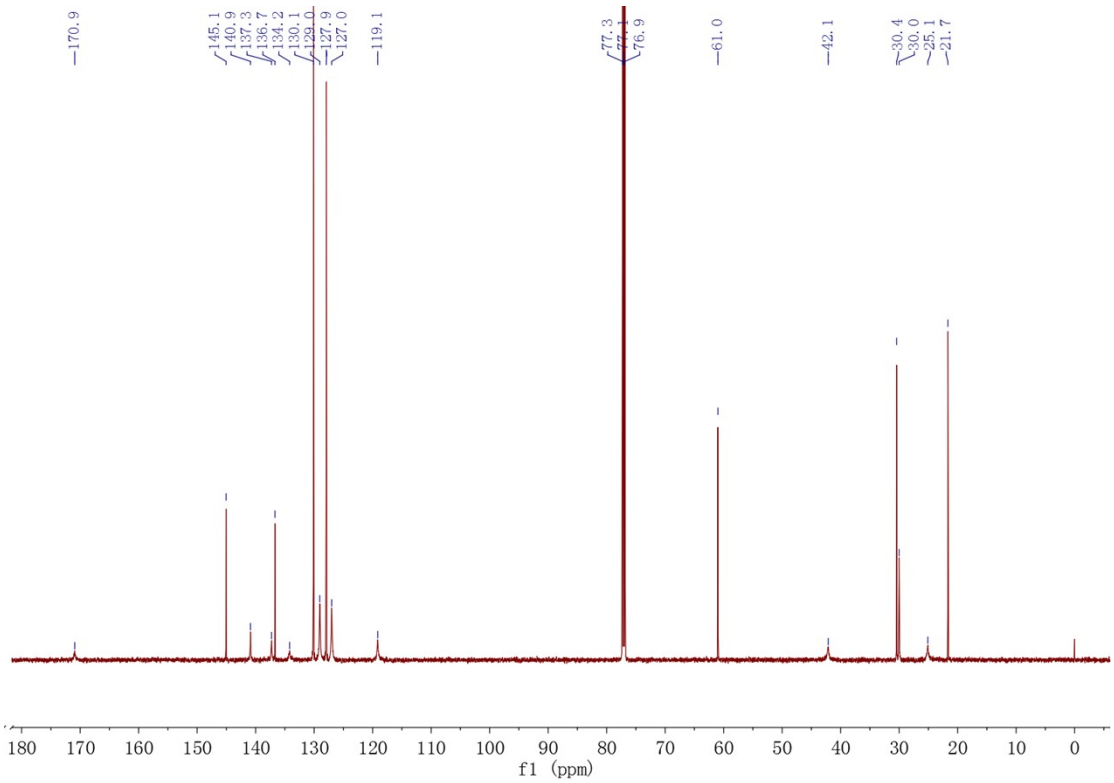
4.00
3.63
3.62
3.60
3.20
3.19
3.17
3.15
3.14
2.47
2.13
1.73
1.62
2.00
2.06
1.90
1.91
0.98
0.97
1.04
1.07
1.00
1.01
3.05
1.04
0.99
2.72
f1 (ppm)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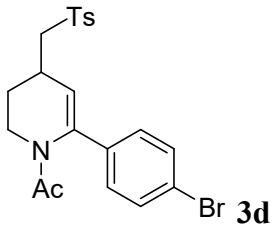
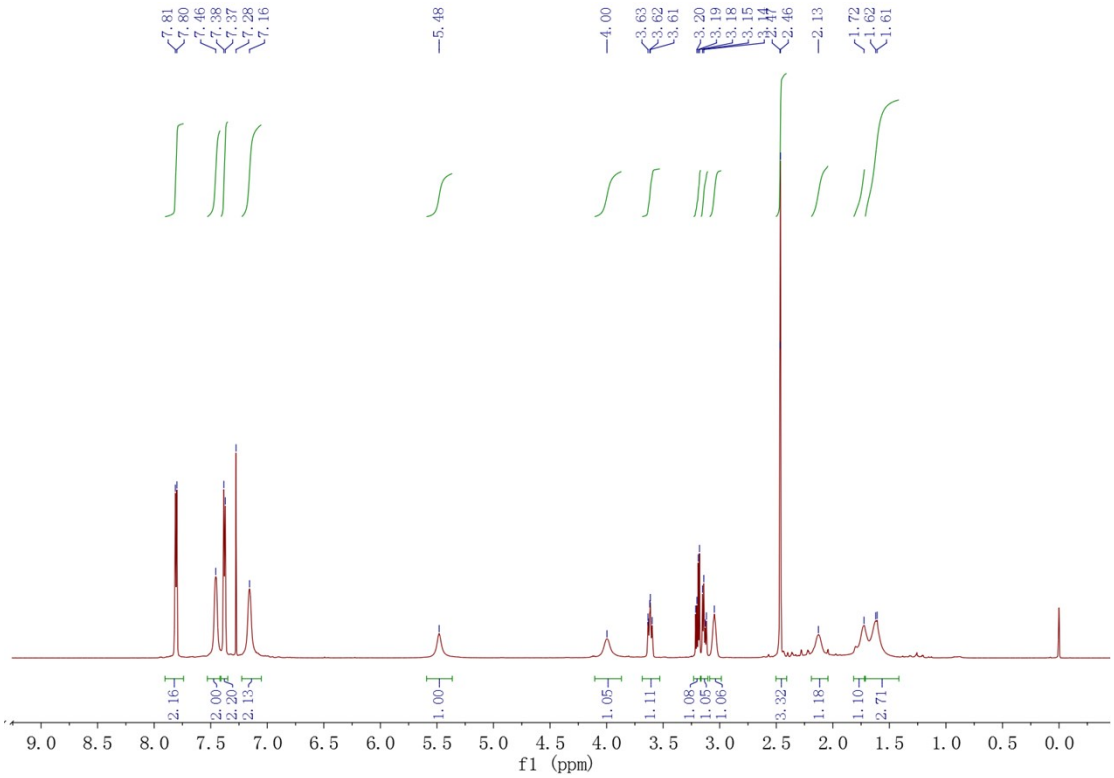
136.7
134.2
130.1
129.0
127.9
127.0
119.1
77.3
77.1
76.9
61.0
42.1
30.4
30.0
25.1
21.7
f1 (ppm)


Ts
N
Ac
Br

3d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7.28
7.16
5.48
4.00
3.63
3.62
3.61
3.20
3.19
3.18
3.15
2.46
2.13
1.72
1.62
1.61
2.16
2.00
2.20
2.13
1.00
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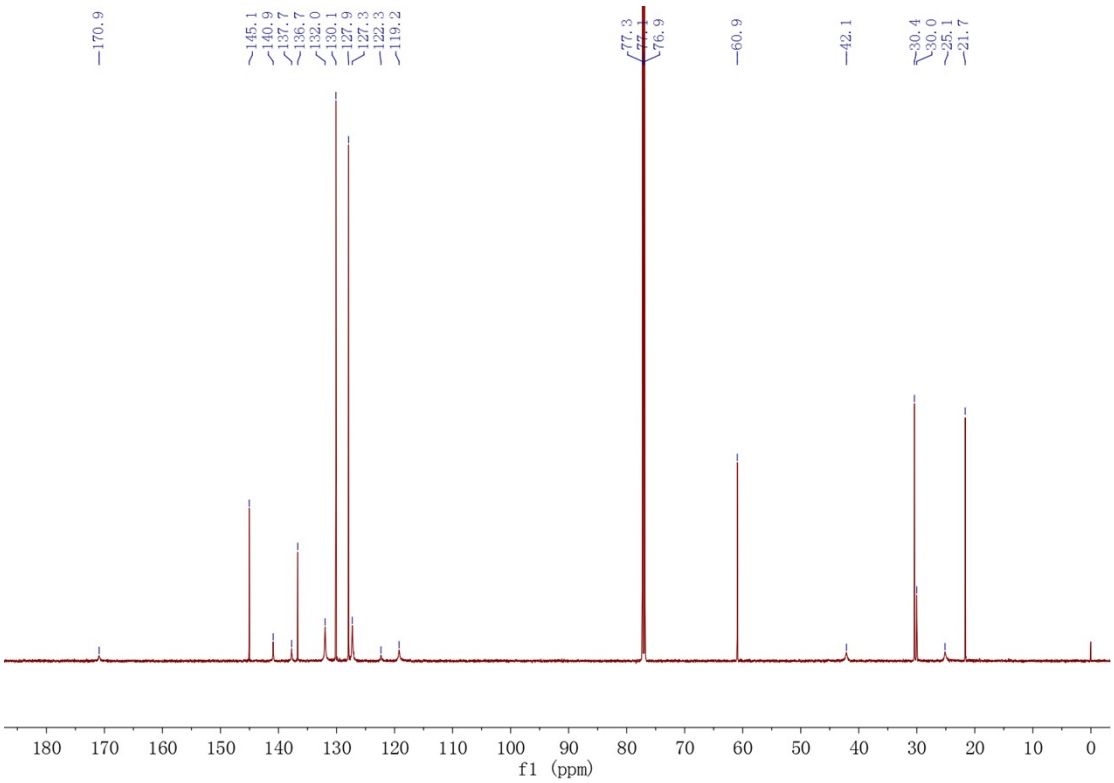
1.11
1.08
1.05
1.06
3.32
1.18
1.10
2.71
f1 (ppm)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140.9
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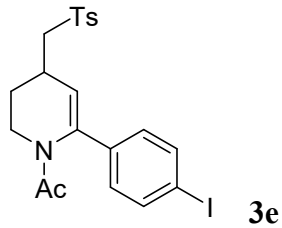
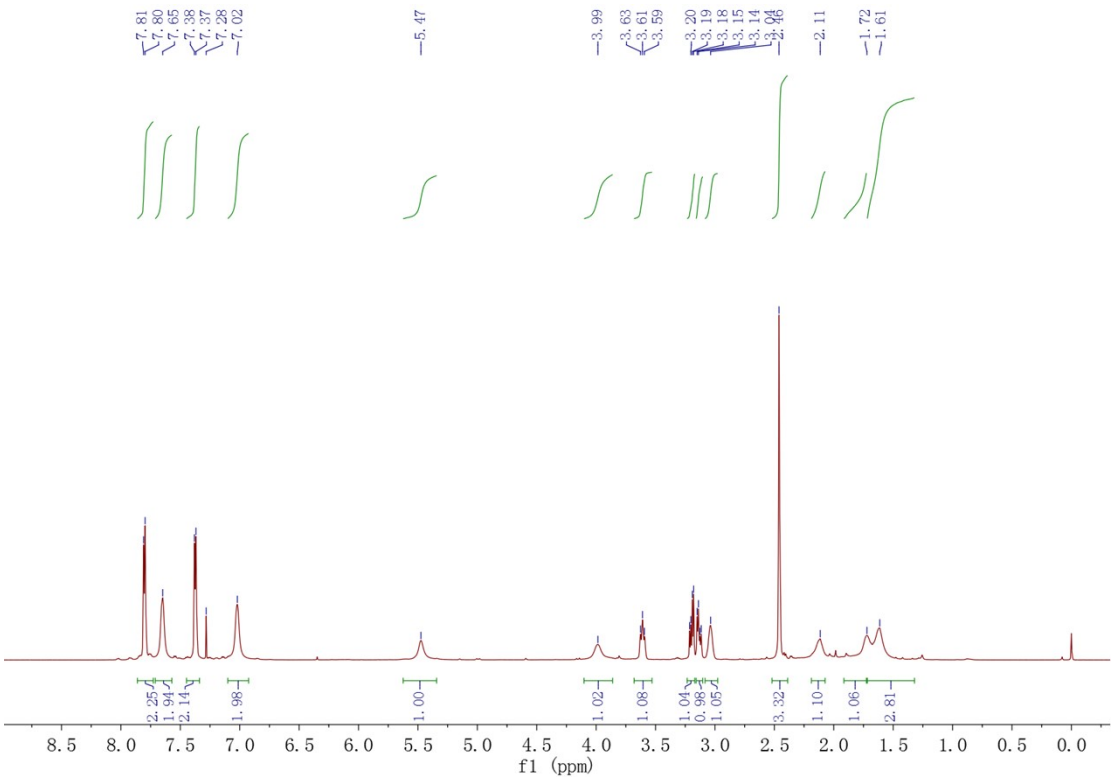
136.7
132.0
130.1
127.9
127.3
122.3
119.2
77.3
77.1
76.9
60.9
42.1
30.4
30.0
25.1
21.7
f1 (ppm)


Ts
N
Ac
I

3e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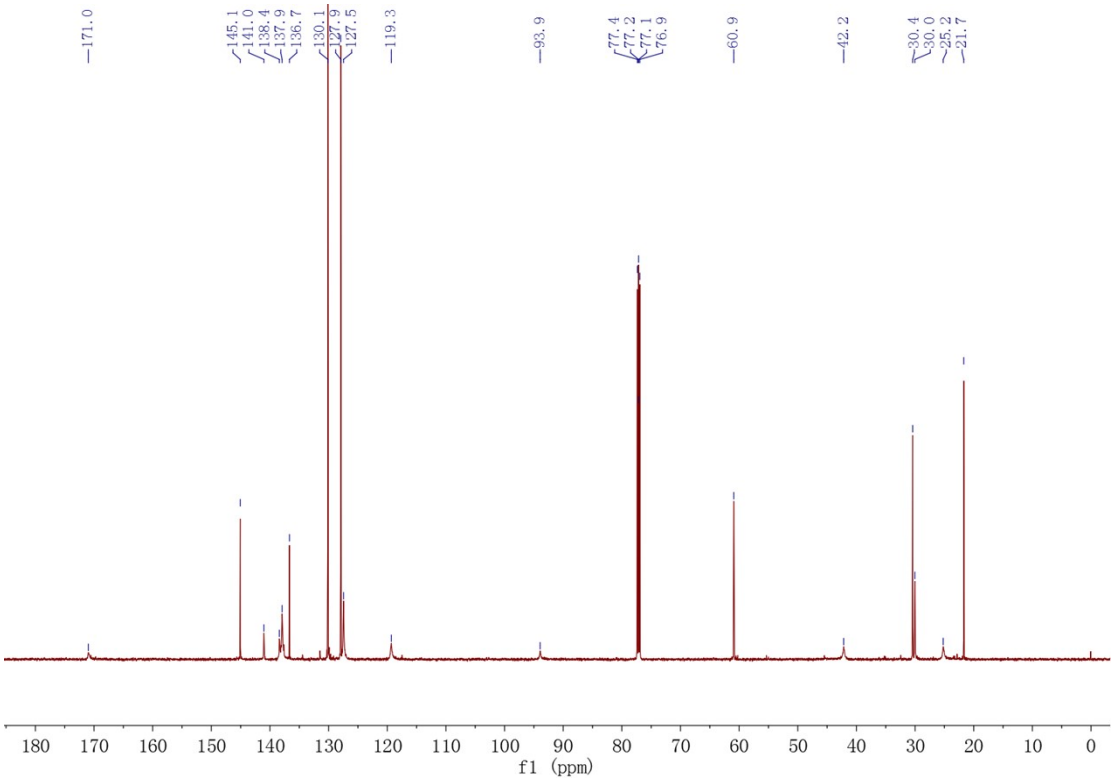
7.80
7.65
7.38
7.37
7.28
7.02
5.47
3.99
3.63
3.61
3.59
3.20
3.19
3.18
3.15
3.14
3.04
2.46
2.11
1.72
1.61
2.25
1.94
2.14
1.98
1.00
1.02
1.08
1.04
0.98
1.05
3.32
1.10
1.06
2.81
f1 (ppm)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141.0
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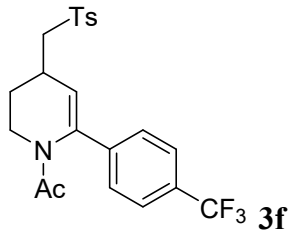
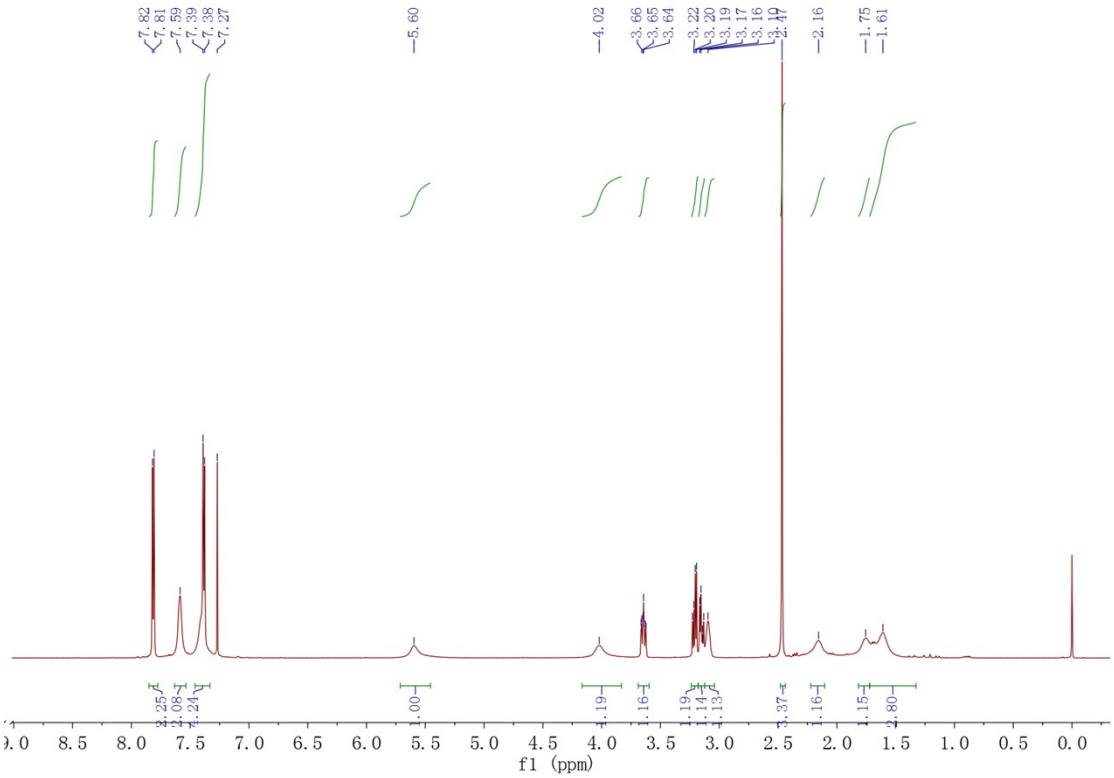
137.9
136.7
130.1
127.9
127.5
119.3
93.9
77.4
77.2
77.1
76.9
60.9
42.2
30.4
30.0
25.2
21.7
f1 (ppm)


Ts
N
Ac
CF3

3f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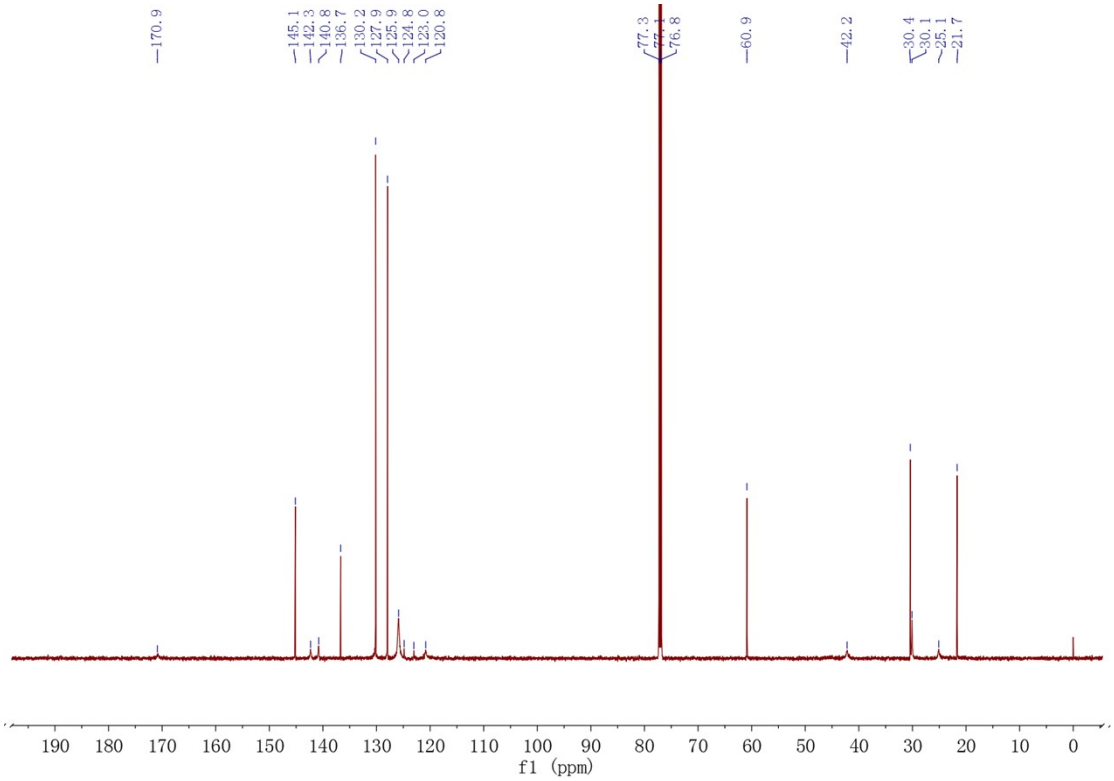
7.81
7.59
7.39
7.38
7.27
5.60
4.02
3.66
3.65
3.64
3.22
3.20
3.19
3.17
3.16
2.16
1.75
1.61
2.25
2.08
2.24
1.00
1.19
1.16
1.19
1.14
1.13
3.37
1.16
1.15
2.80
f1 (ppm)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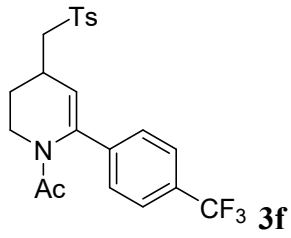
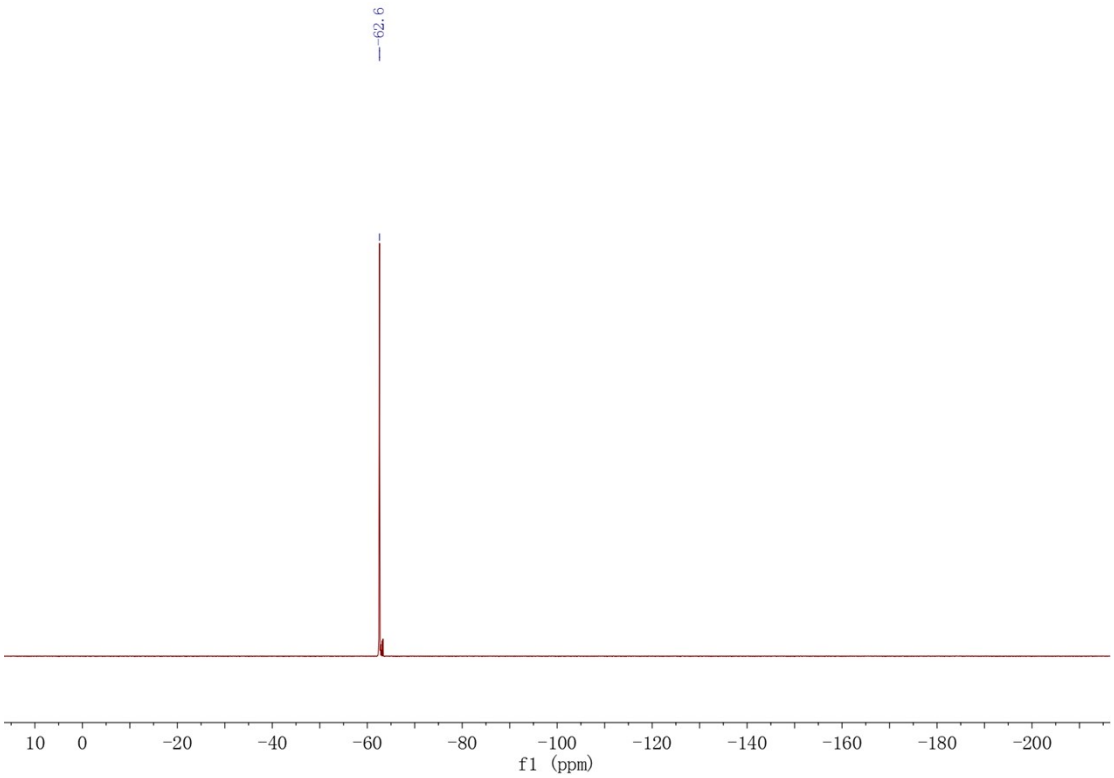
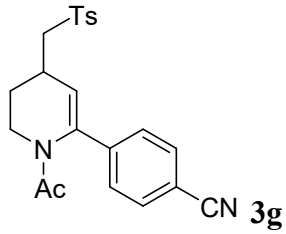
145.1
142.3
140.8
136.7
130.2
127.9
125.9
124.8
123.0
120.8
77.3
77.1
76.8
60.9
42.2
30.4
30.1
25.1
21.7
f1 (ppm)

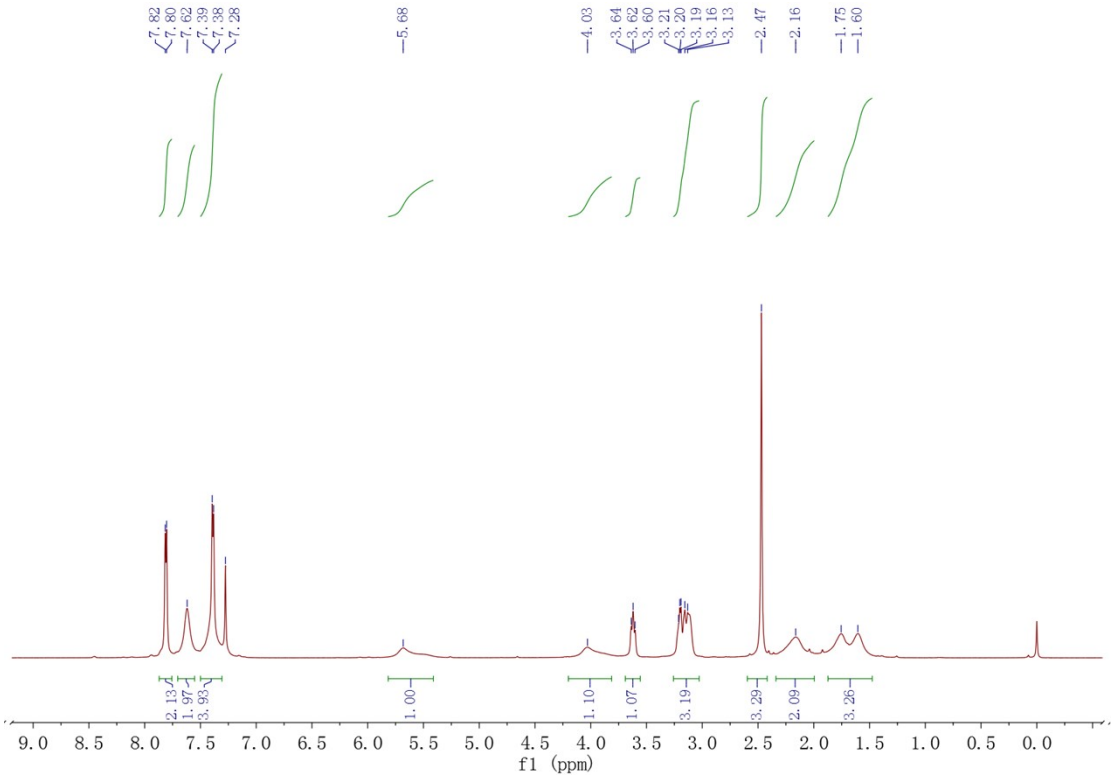

Ts
N
Ac
CF3

3f





3g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7.80
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7.39
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7.28
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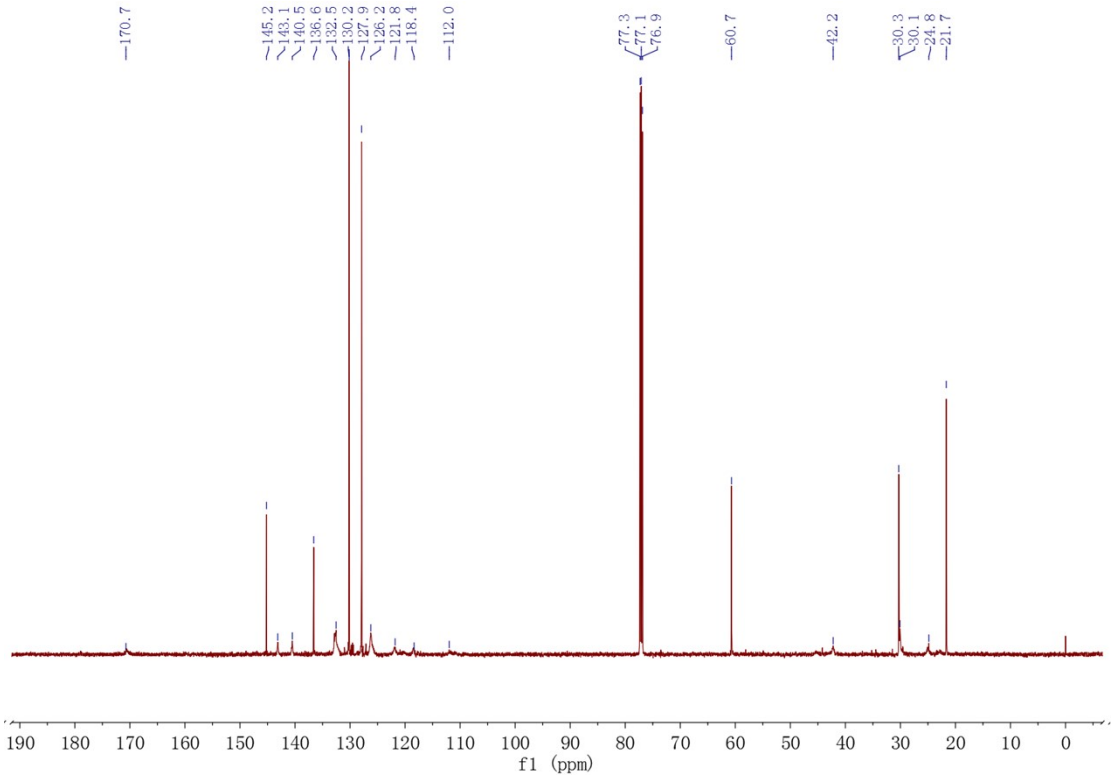
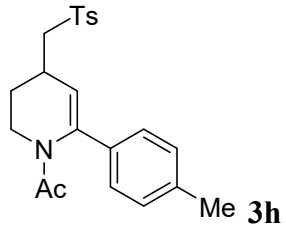
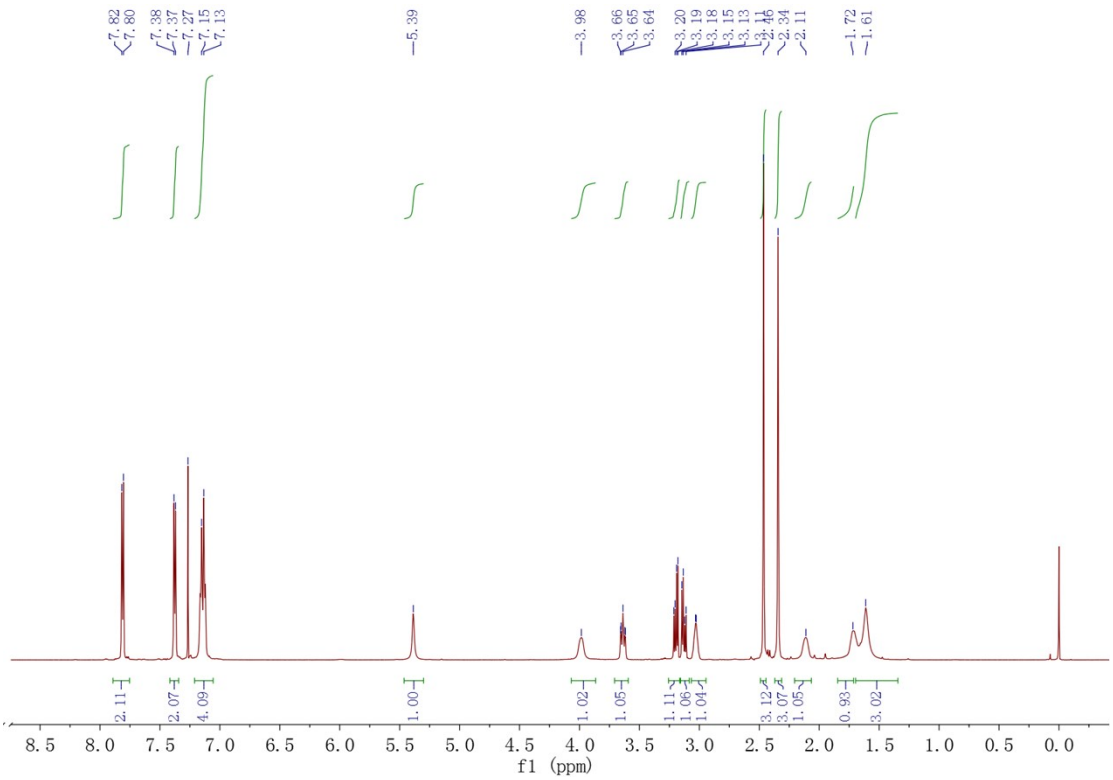
4.03
3.64
3.62
3.60
3.21
3.20
3.19
3.16
3.13
2.47
2.16
1.75
1.60
2.13
1.97
3.93
1.00
1.10
1.07
3.19
3.29
2.09
3.26
f1 (ppm)


170.7
145.2
143.1
140.5
136.6
132.5
130.2
127.9
126.2
121.8
118.4
112.0
77.3
77.1
76.9
60.7
42.2
30.3
30.1
24.8
21.7
f1 (ppm)


Ts
N
Ac
Me

3h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7.15
7.13
5.39
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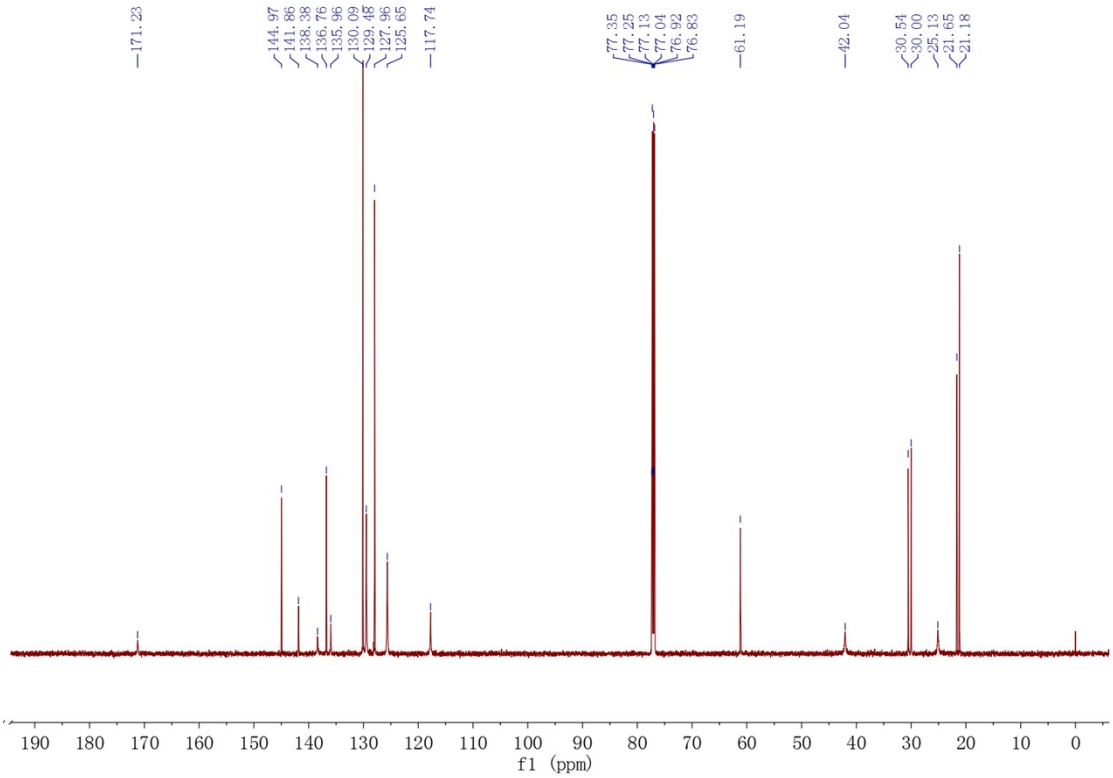
3.66
3.65
3.64
3.20
3.19
3.18
3.15
3.13
2.34
2.11
1.72
1.61
2.11
2.07
4.09
1.00
1.02
1.05
1.11
1.06
1.04
3.12
3.07
1.05
0.93
3.02
f1 (ppm)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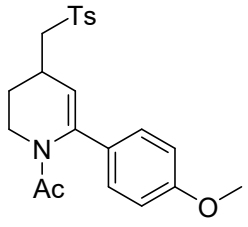
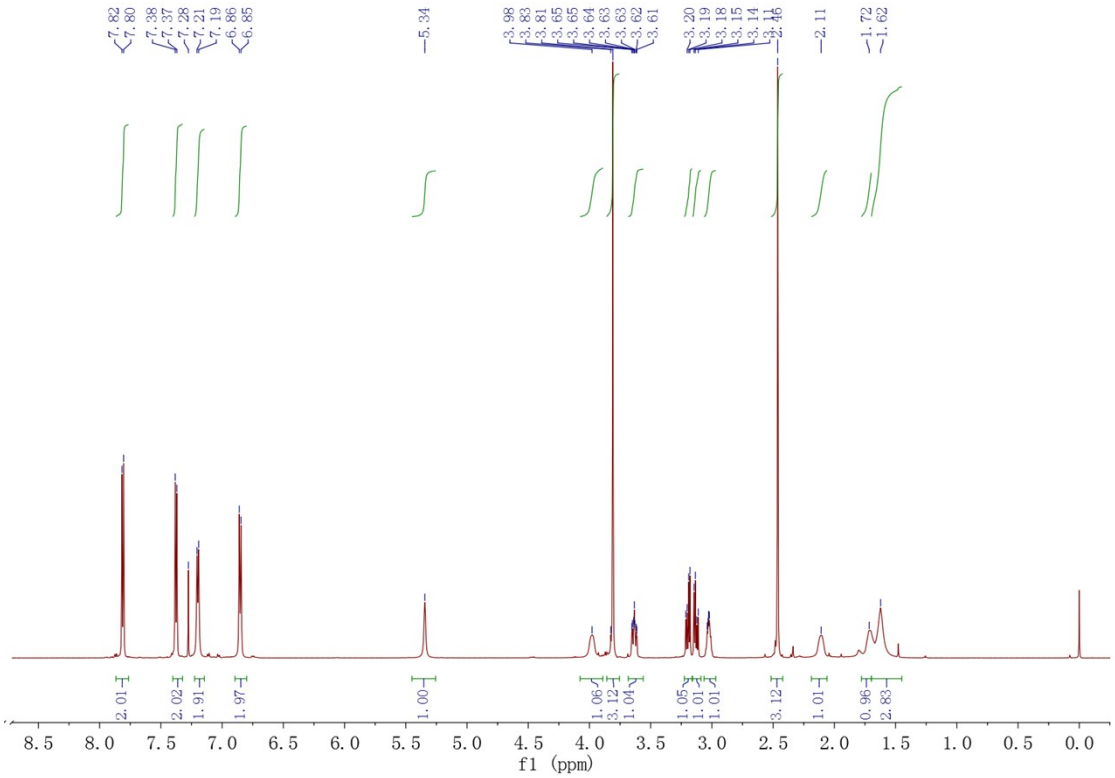
136.76
135.96
130.09
129.48
127.96
125.65
117.74
77.35
77.25
77.13
77.04
76.92
76.83
61.19
42.04
30.54
30.00
25.13
21.65
21.18
f1 (ppm)


Ts
N
Ac
O

3i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7.19
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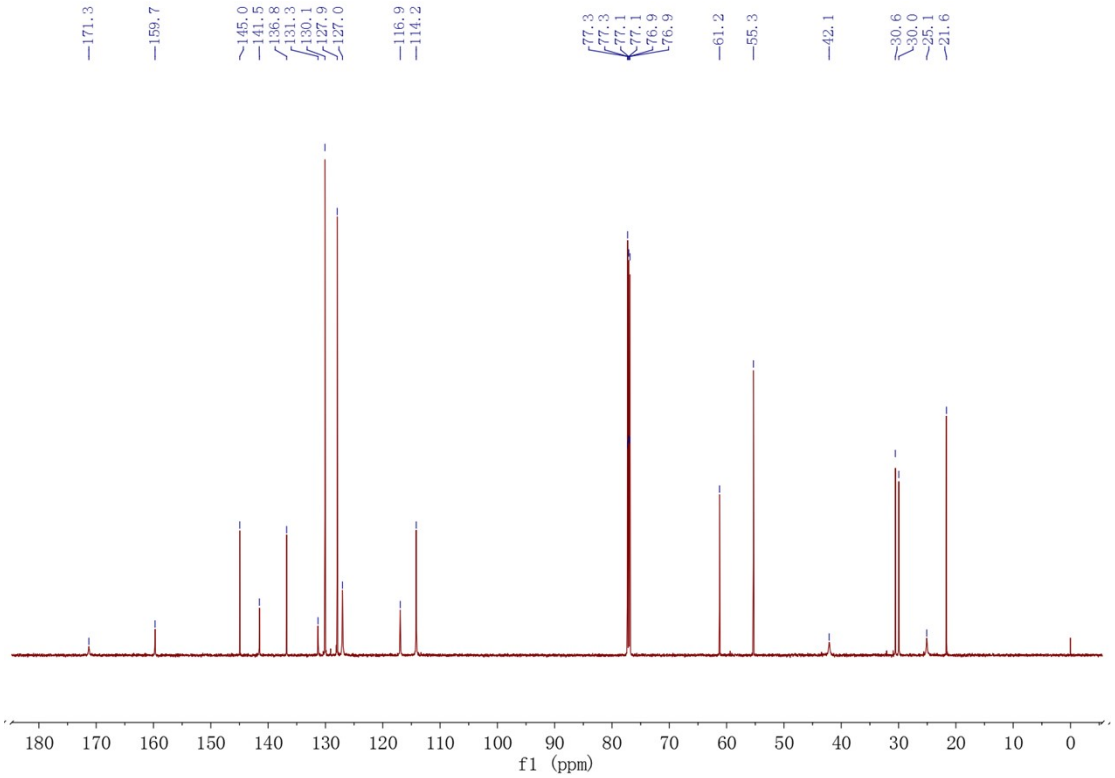
6.85
5.34
3.98
3.83
3.81
3.65
3.65
3.64
3.63
3.63
3.62
3.61
3.20
3.19
3.18
3.15
3.14
3.11
2.46
2.11
1.72
1.62
2.01
2.02
1.91
1.97
1.00
1.06
3.12
1.04
1.05
1.01
1.01
3.12
1.01
0.96
2.83
f1 (ppm)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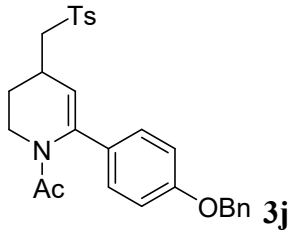
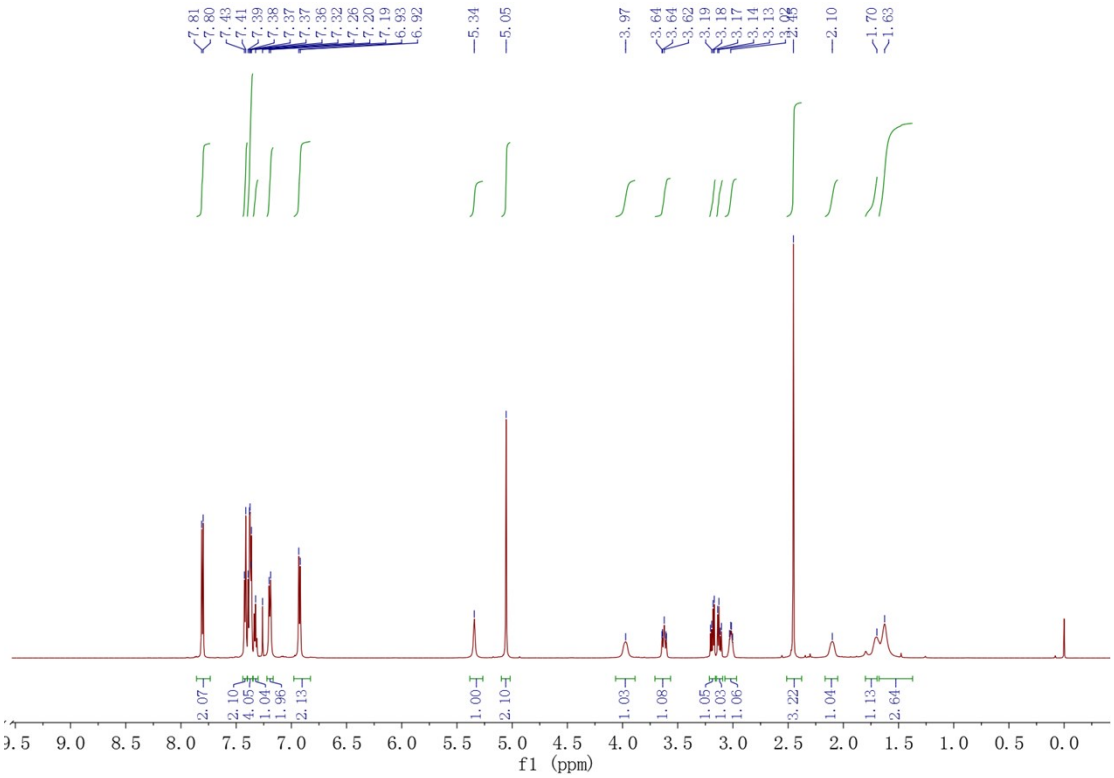
136.8
131.3
130.1
127.9
127.0
116.9
114.2
77.3
77.3
77.1
77.1
76.9
76.9
61.2
55.3
42.1
30.6
30.0
25.1
21.6
f1 (ppm)


Ts
N
Ac
OBn

3j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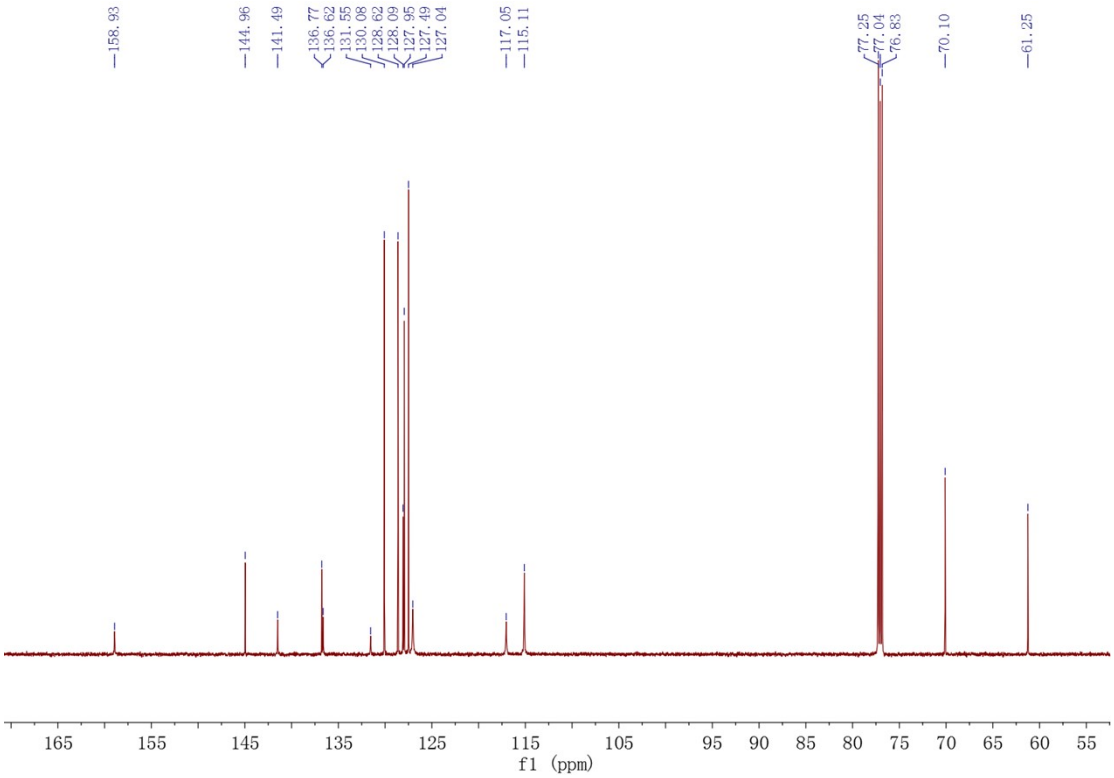
7.36
7.32
7.26
7.20
7.19
6.93
6.92
5.34
5.05
3.97
3.64
3.64
3.62
3.19
3.18
3.17
3.14
3.13
2.10
1.70
1.63
2.07
2.10
4.05
1.04
1.96
2.13
1.00
2.10
1.03
1.08
1.05
1.03
1.06
3.22
1.04
1.13
2.64
f1 (ppm)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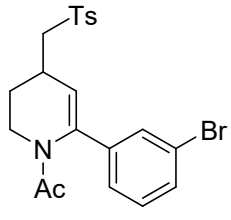
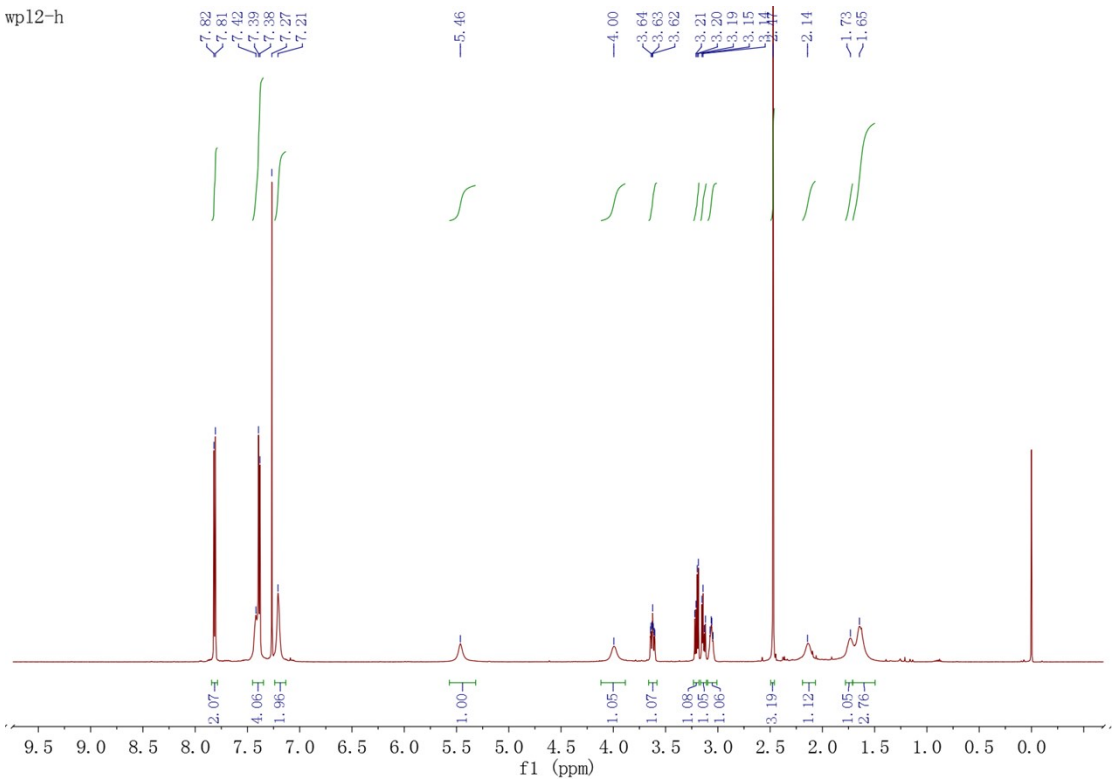
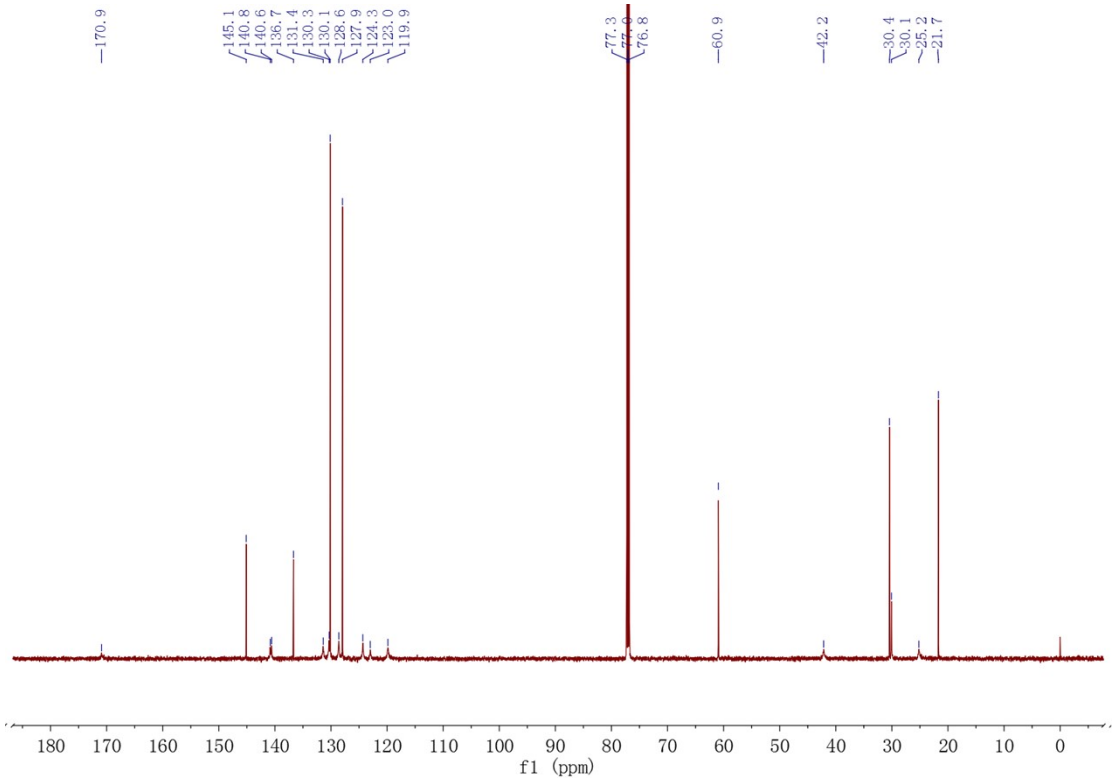
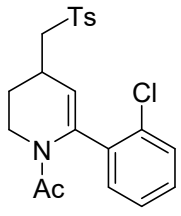
136.62
131.55
130.08
128.62
128.09
127.95
127.49
127.04
117.05
115.11
77.25
77.04
76.83
70.10
61.25
f1 (ppm)


Ts
Br
N
Ac

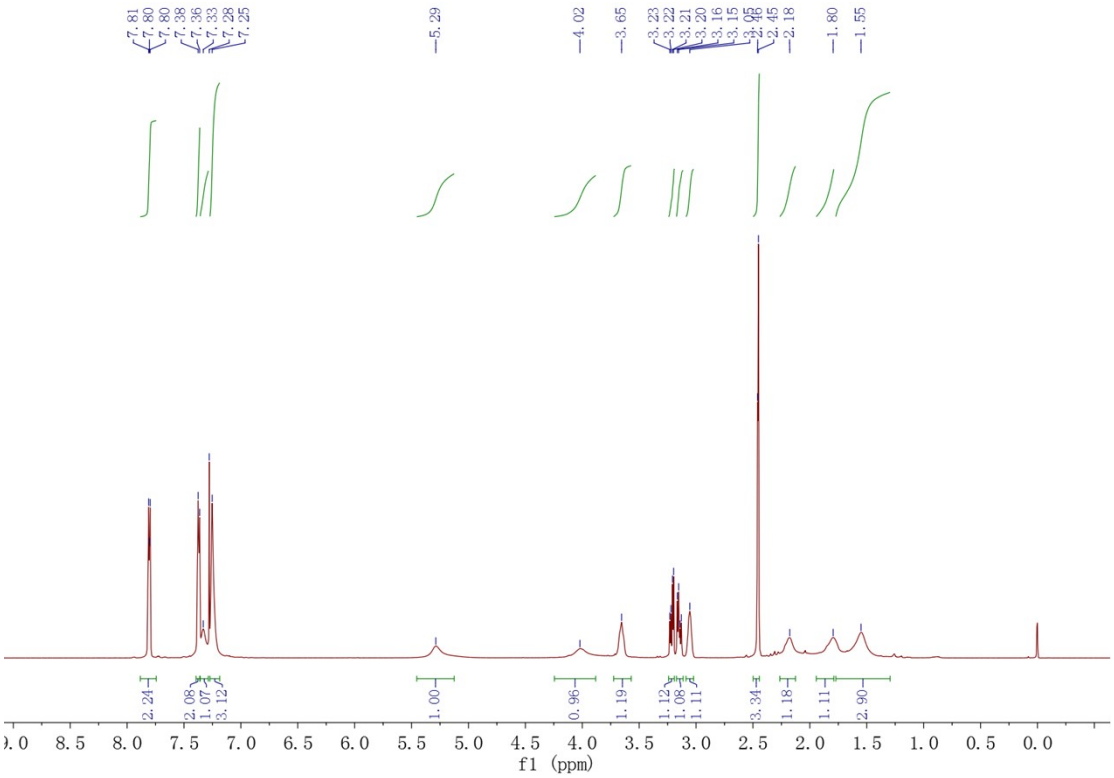
3k







3l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7.80
7.38
7.36
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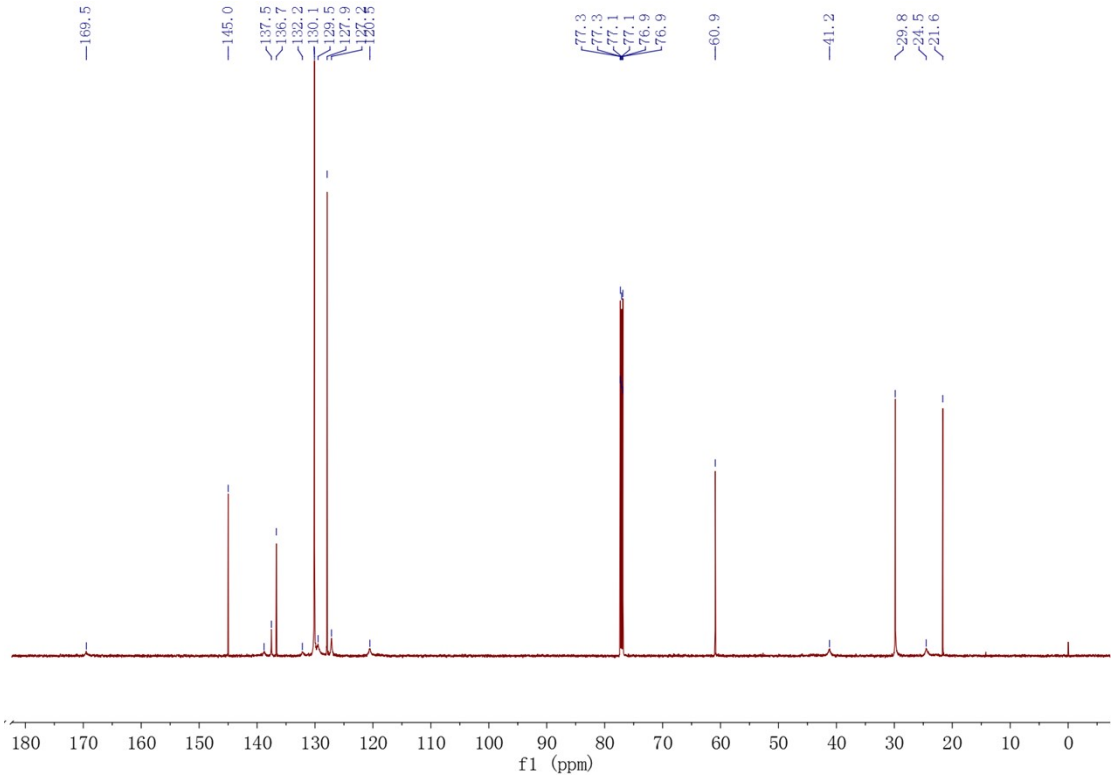
7.28
7.25
5.29
4.02
3.65
3.23
3.22
3.21
3.20
3.16
3.15
2.45
2.18
1.80
1.55
2.24
2.08
1.07
3.12
1.00
0.96
1.19
1.12
1.08
1.11
3.34
1.18
1.11
2.90
f1 (ppm)


169.5
145.0
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136.7
132.2
130.1
129.5
127.9
77.3
77.3
77.1
77.1
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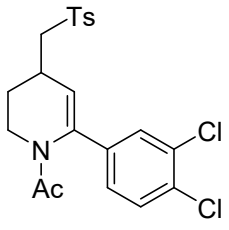
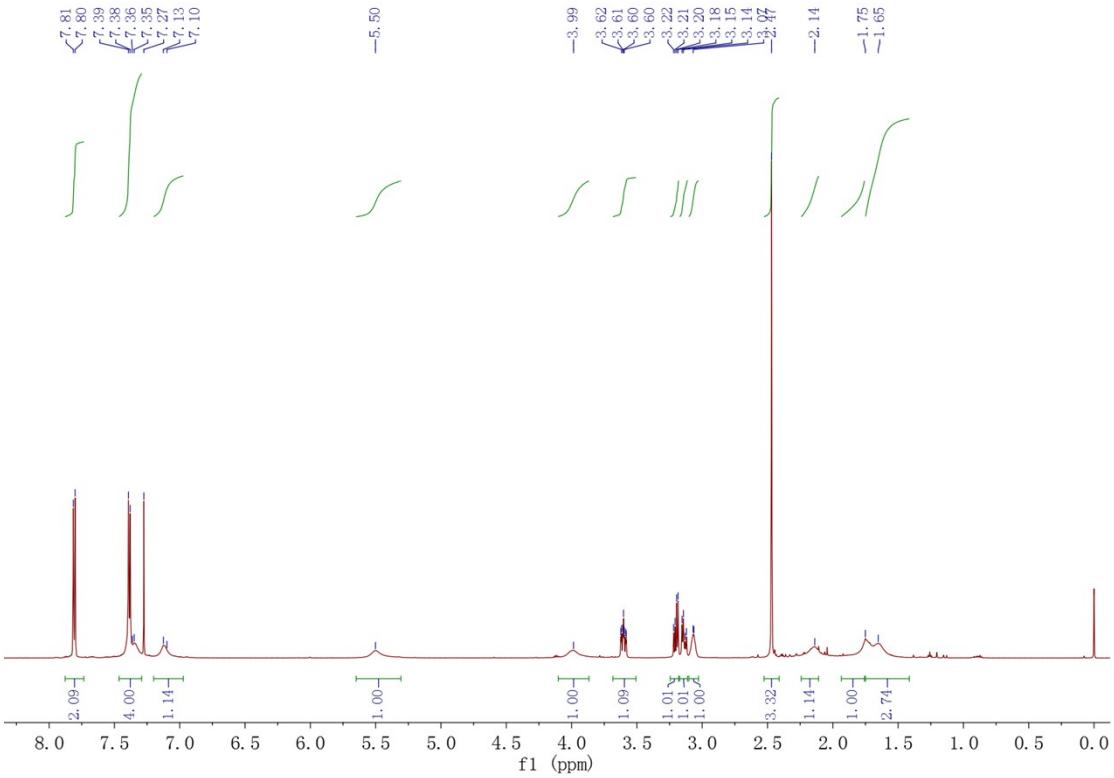
41.2
29.8
24.5
21.6
f1 (ppm)


Ts
N
Ac
Cl
Cl

3m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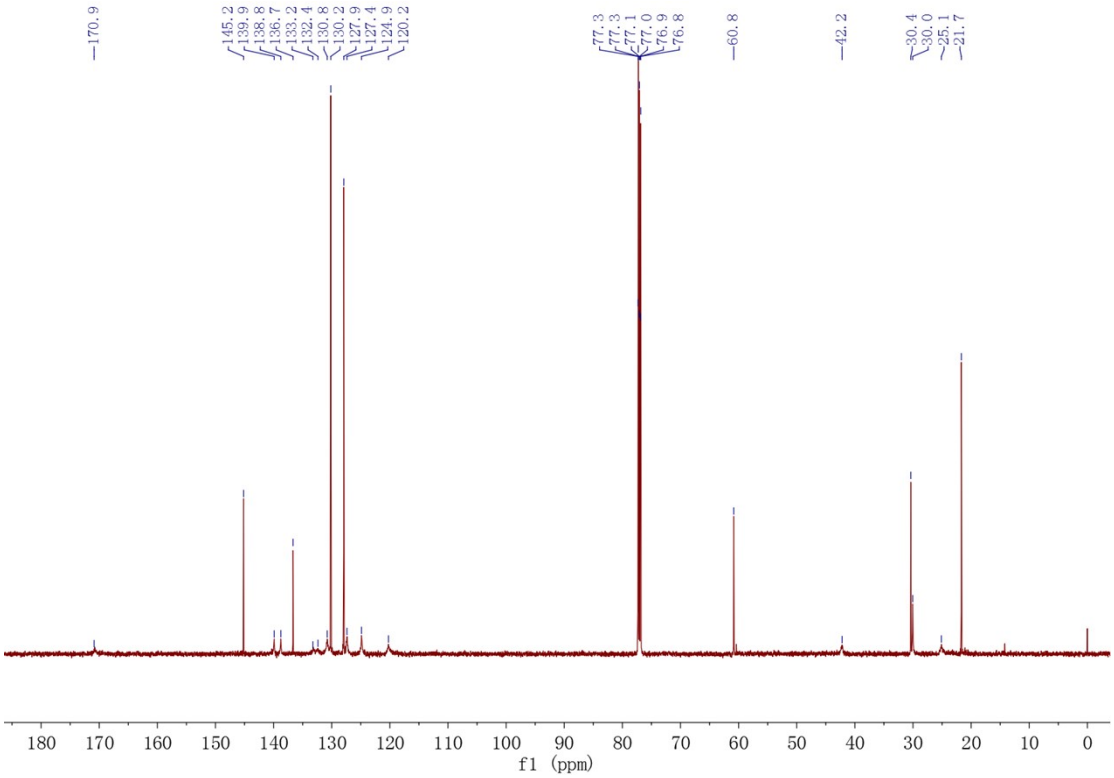
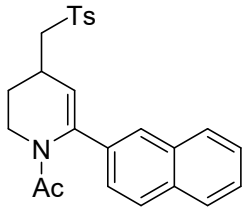
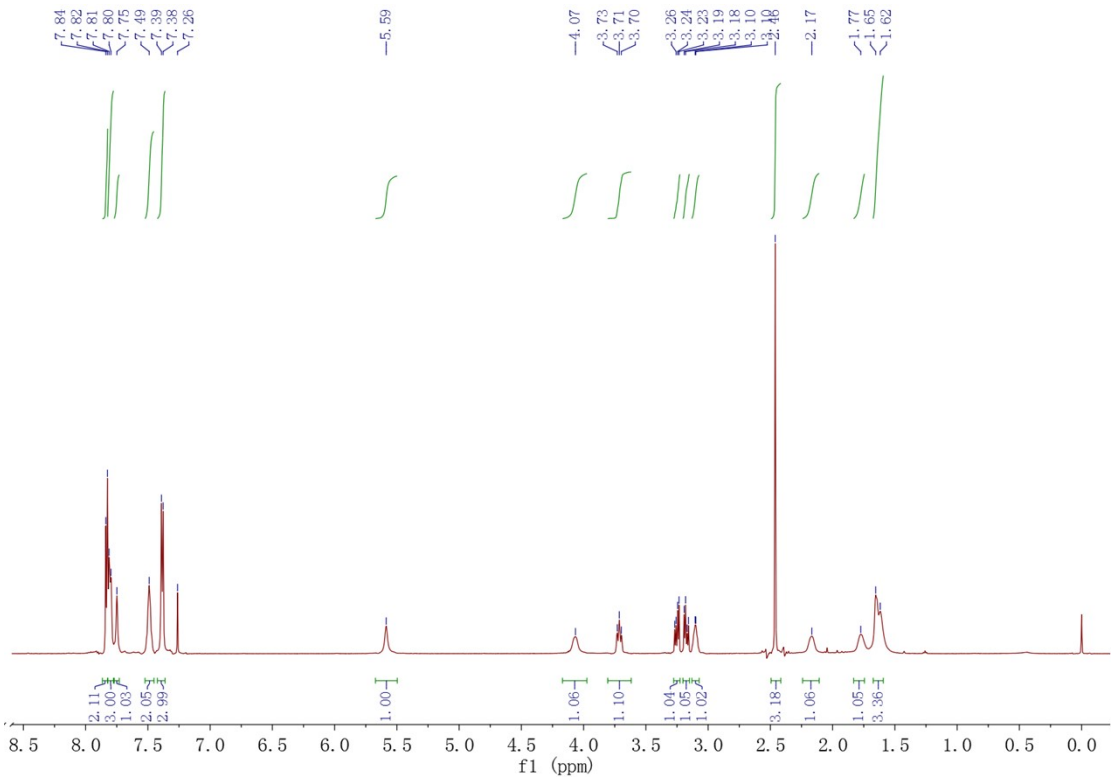
7.80
7.39
7.38
7.36
7.35
7.27
7.13
7.10
5.50
3.99
3.62
3.61
3.60
3.60
3.22
3.21
3.20
3.18
3.15
3.14
2.14
1.75
1.65
2.09
4.00
1.14
1.00
1.00
1.09
1.01
1.01
1.00
3.32
1.14
1.00
2.74
f1 (ppm)


170.9
145.2
139.9
138.8
136.7
133.2
132.4
130.8
130.2
127.9
127.4
124.9
120.2
77.3
77.3
77.1
77.0
76.9
76.8
60.8
42.2
30.4
30.0
25.1
21.7
f1 (ppm)


Ts
N
Ac

3n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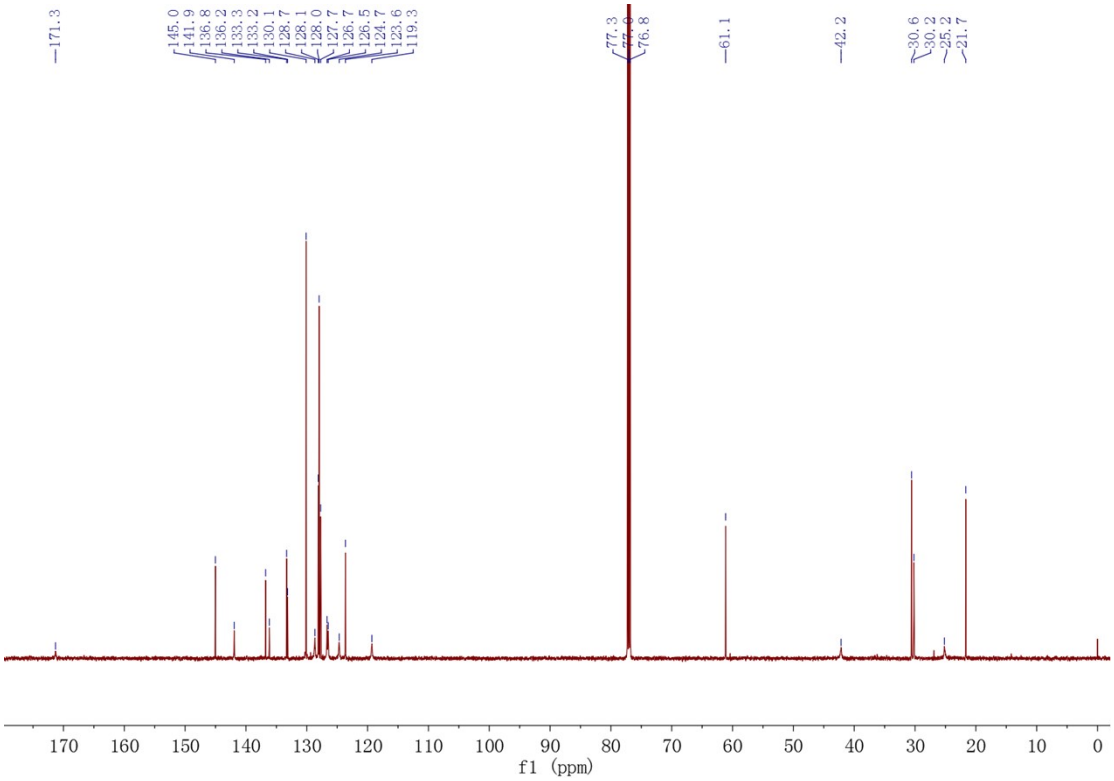
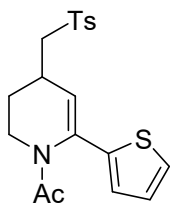
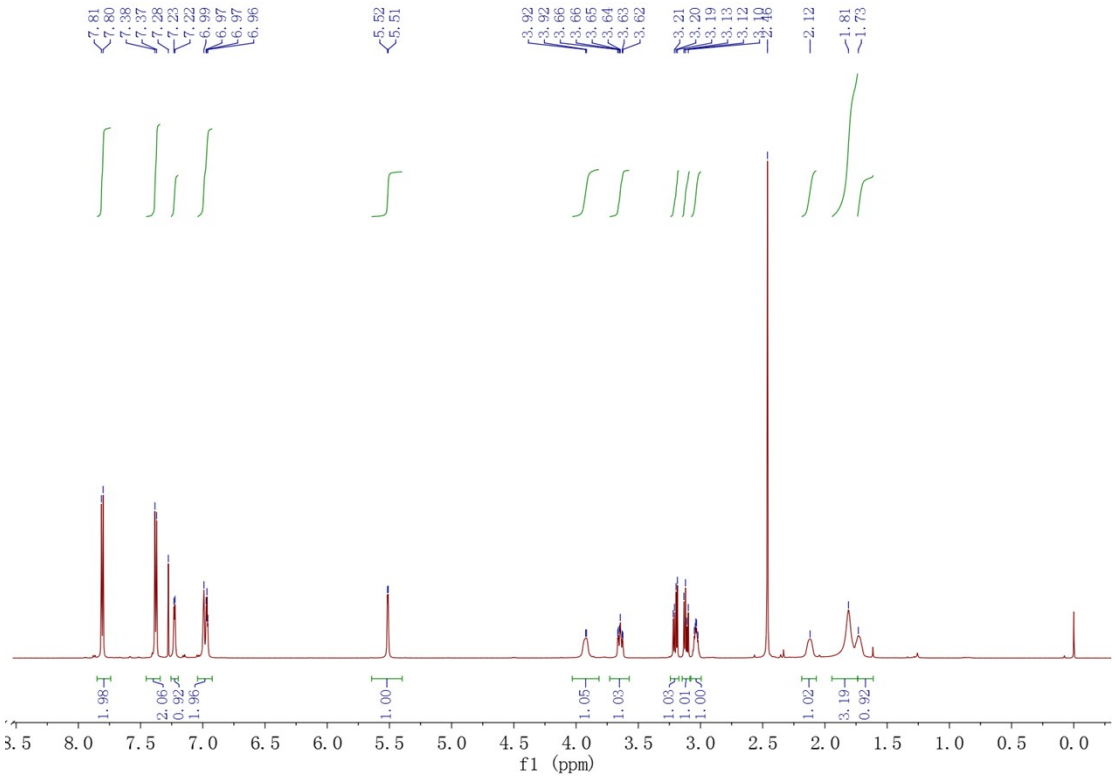
7.82
7.81
7.80
7.75
7.49
7.39
7.38
7.26
5.59
4.07
3.73
3.71
3.70
3.26
3.24
3.23
3.19
3.18
3.10
2.48
2.17
1.77
1.65
1.62
2.11
3.00
1.03
2.05
2.99
1.00
1.06
1.10
1.04
1.05
1.02
3.18
1.06
1.05
3.36
f1 (ppm)


171.3
145.0
141.9
136.8
136.2
133.3
133.2
130.1
128.7
128.1
128.0
127.7
126.7
126.5
124.7
123.6
119.3
77.3
77.0
76.8
61.1
42.2
30.6
30.2
25.2
21.7
f1 (ppm)


Ts
S
N
Ac

3o


7.81
7.80
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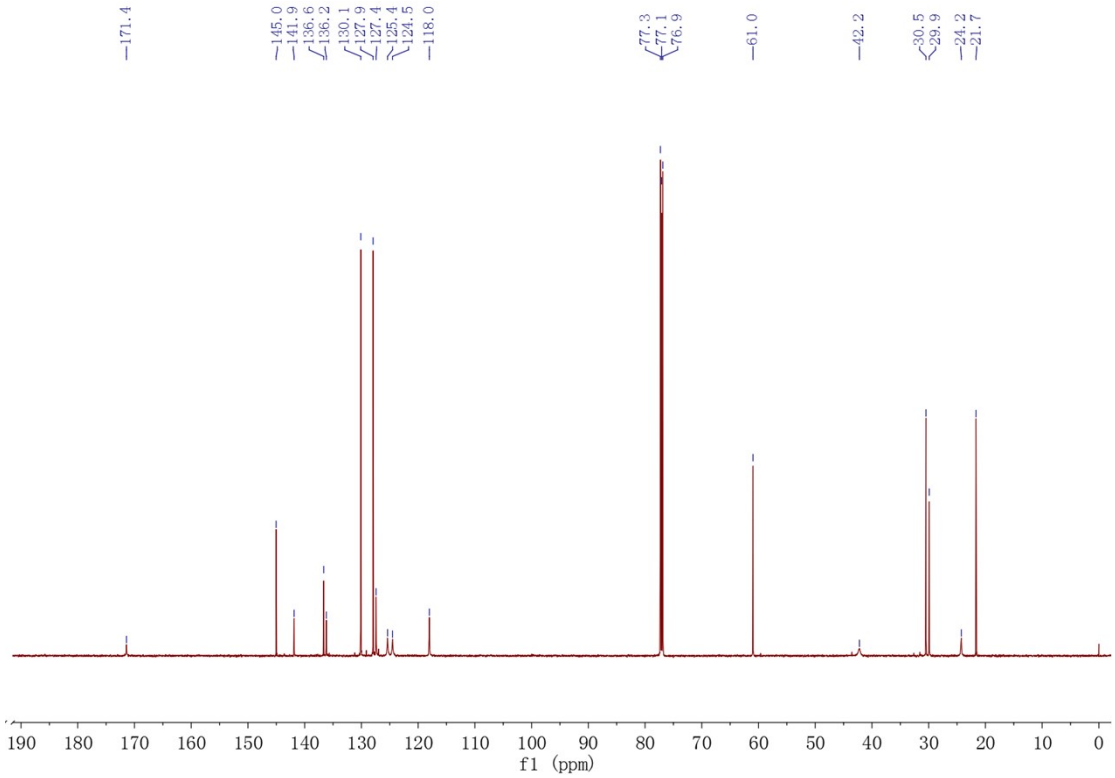
7.37
7.28
7.23
7.22
6.99
6.97
6.97
6.96
5.52
5.51
3.92
3.92
3.66
3.66
3.65
3.64
3.63
3.62
3.21
3.20
3.19
3.13
3.12
2.48
2.12
1.81
1.73
1.98
2.06
0.92
1.96
1.00
1.05
1.03
1.03
1.01
1.00
1.02
3.19
0.92
f1 (ppm)


171.4
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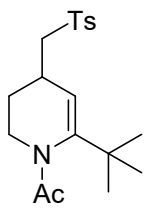
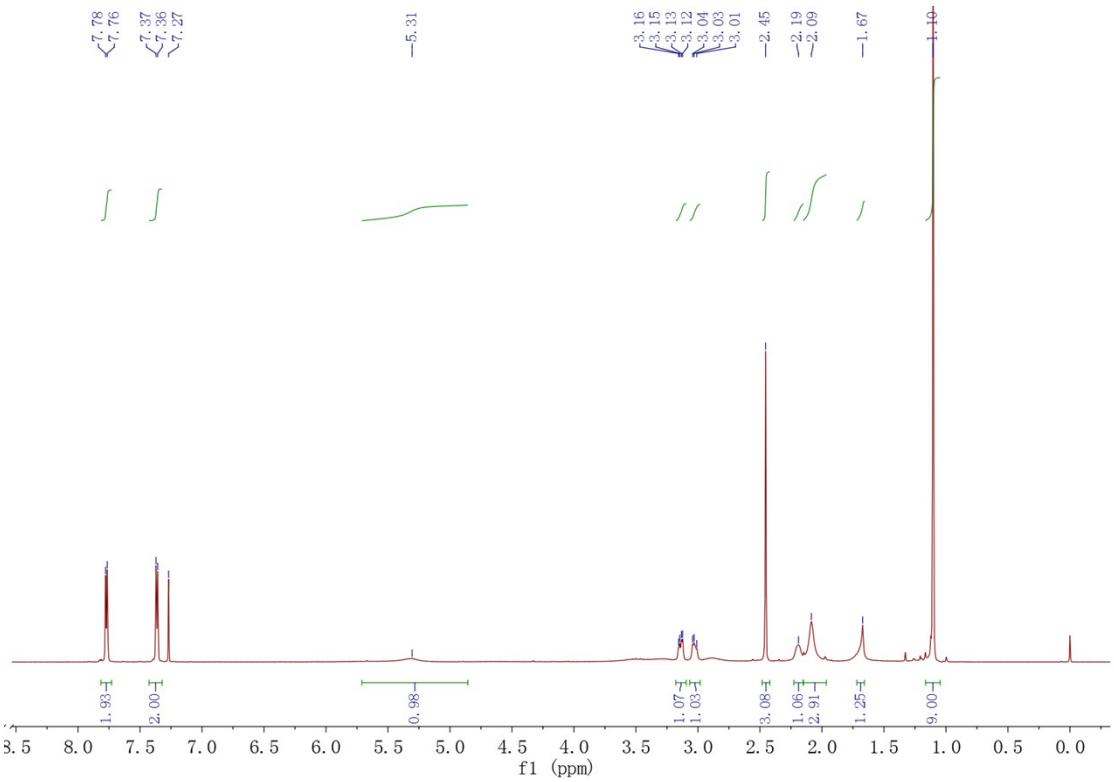
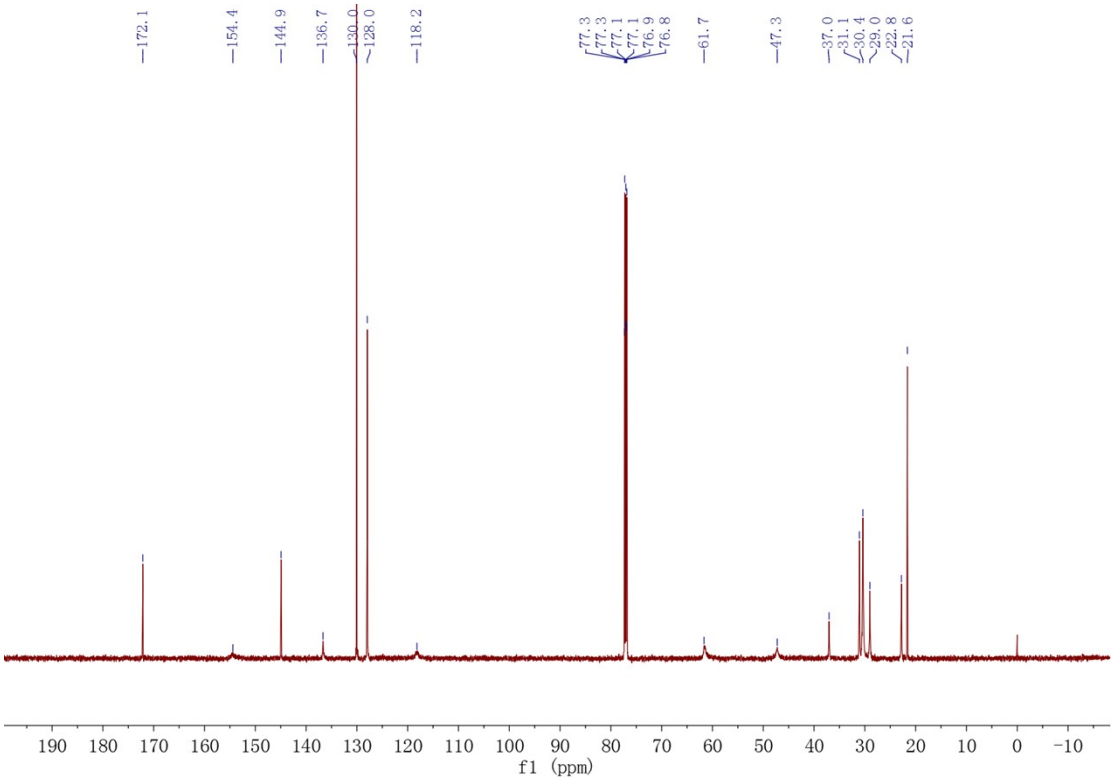
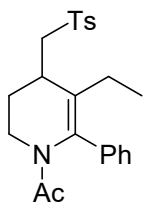
141.9
136.6
136.2
130.1
127.9
127.4
125.4
124.5
118.0
77.3
77.1
76.9
61.0
42.2
30.5
29.9
24.2
21.7
f1 (ppm)


Ts
N
Ac

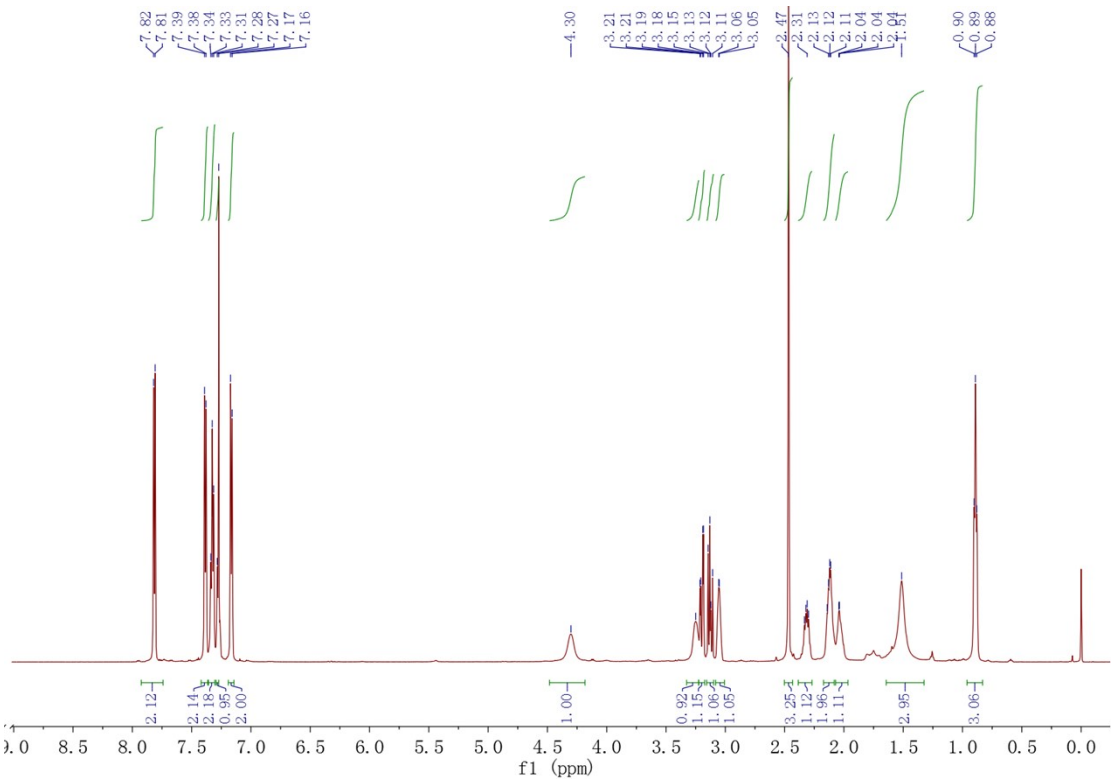
3p

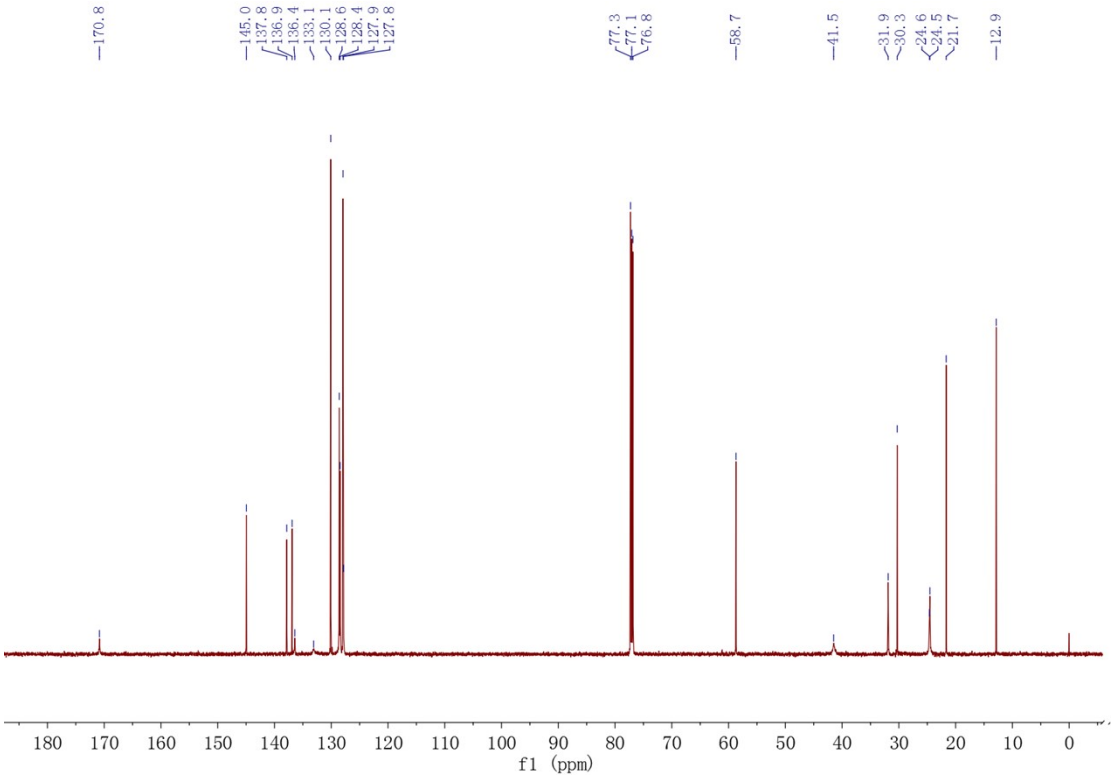

7.78
7.76
7.37
7.36
7.27
5.31
3.16
3.15
3.13
3.12
3.04
3.03
3.01
2.45
2.19
2.09
1.67
1.10
1.93
2.00
0.98
1.07
1.03
3.08
1.06
2.91
1.25
9.00
f1 (ppm)

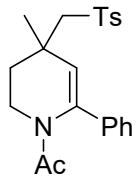

172.1
154.4
144.9
136.7
130.0
128.0
118.2
77.3
77.3
77.1
77.1
76.9
76.8
61.7
47.3
37.0
31.1
30.4
29.0
22.8
21.6
f1 (ppm)


Ts
N
Ph
Ac

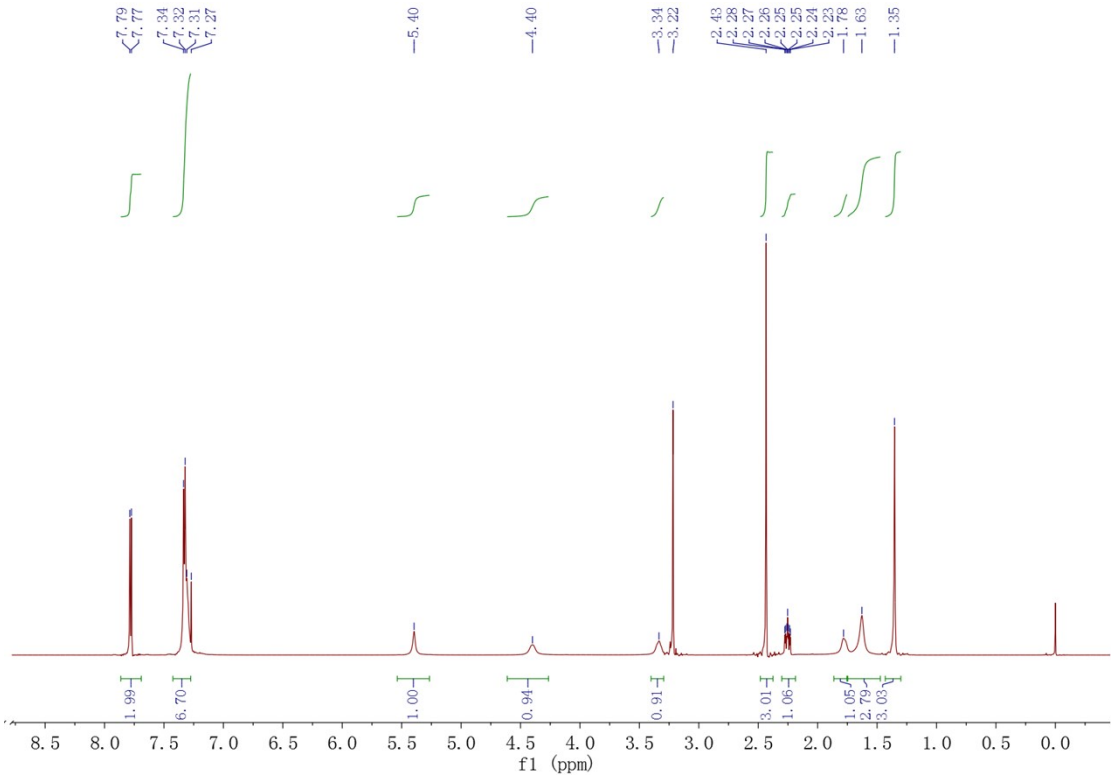
3q

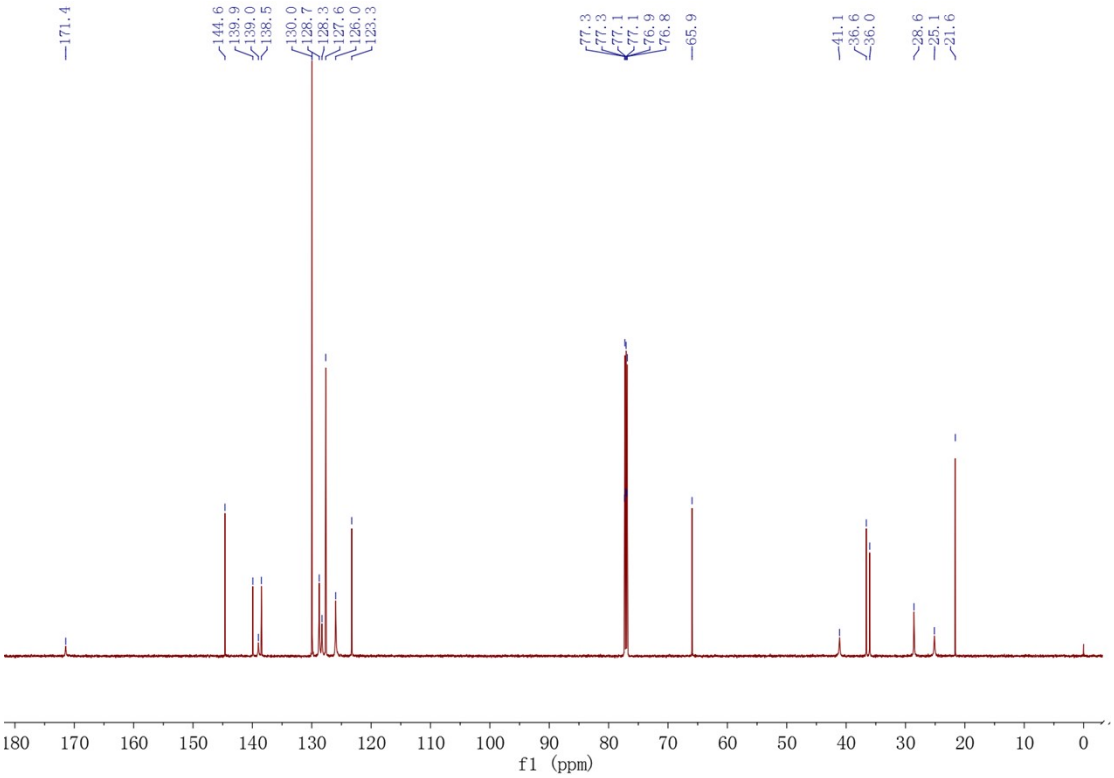

7.82
7.81
7.39
7.38
7.34
7.33
7.31
7.28
7.27
7.17
7.16
4.30
3.21
3.21
3.19
3.18
3.15
3.13
3.12
3.11
3.06
3.05
2.47
2.31
2.13
2.12
2.11
2.04
2.04
1.51
0.90
0.89
0.88
2.12
2.14
2.18
0.95
2.00
1.00
0.92
1.15
1.06
1.05
3.25
1.12
1.96
1.11
2.95
3.06
f1 (ppm)

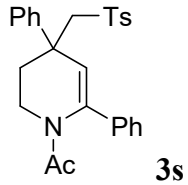

170.8
145.0
137.8
136.9
136.4
133.1
130.1
128.6
128.4
127.9
127.8
77.3
77.1
76.8
58.7
41.5
31.9
30.3
24.6
24.5
21.7
12.9
f1 (ppm)


Ts
Ph
N
Ac

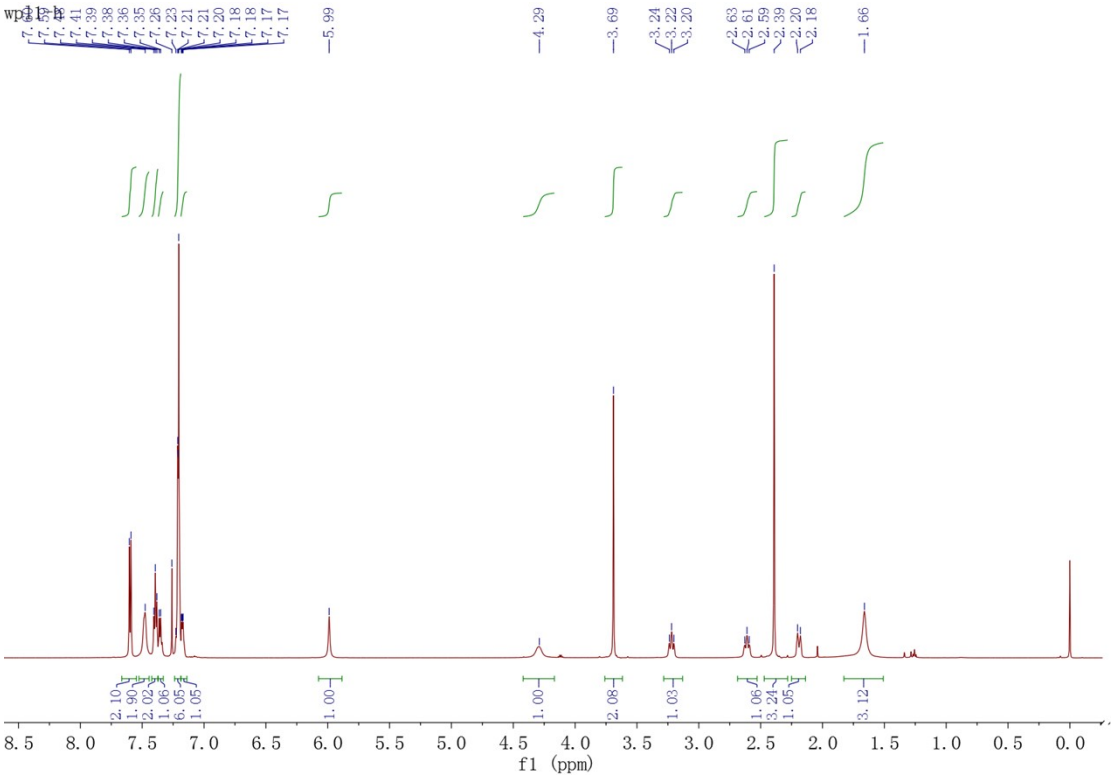
3r

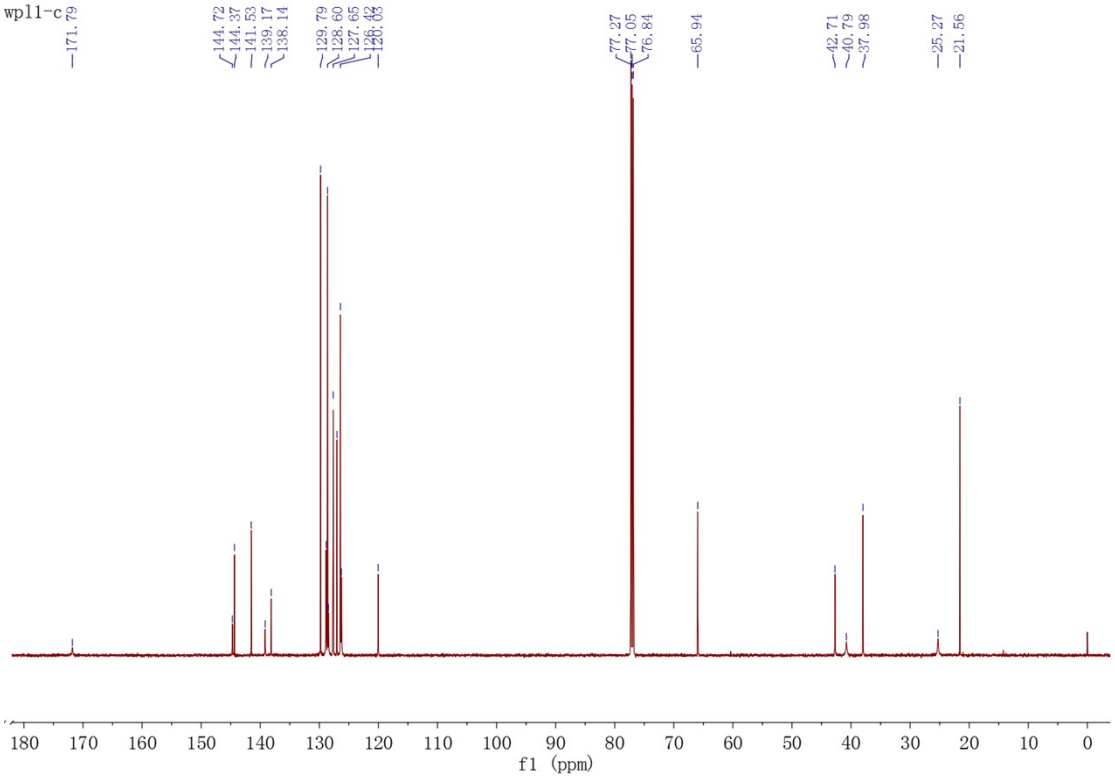

7.79
7.77
7.34
7.32
7.31
7.27
5.40
4.40
3.34
3.22
2.43
2.28
2.27
2.26
2.25
2.25
2.24
2.23
1.78
1.63
1.35
1.99
6.70
1.00
0.94
0.91
3.01
1.06
1.05
2.79
3.03
f1 (ppm)

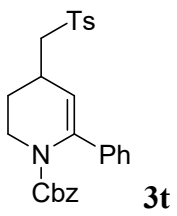

171.4
144.6
139.9
139.0
138.5
130.0
128.7
128.3
127.6
126.0
123.3
77.3
77.3
77.1
77.1
76.9
76.8
65.9
41.1
36.6
36.0
28.6
25.1
21.6
f1 (ppm)


Ph
Ts
N
Ph
Ac

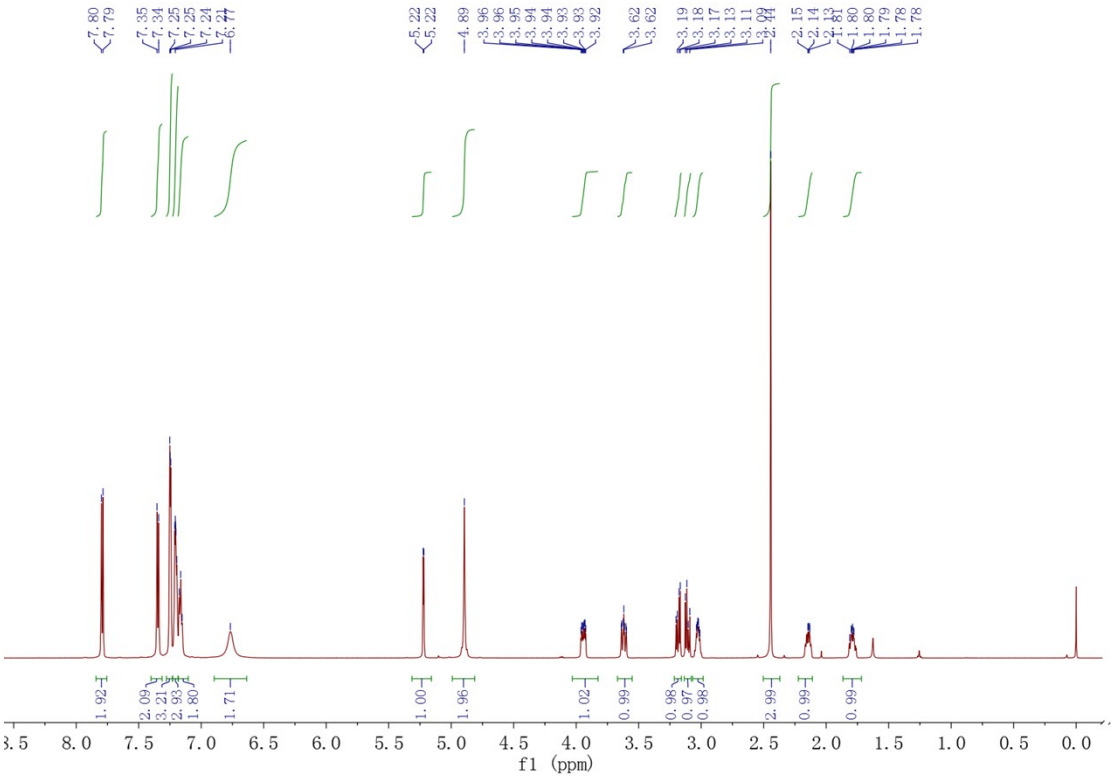
3s

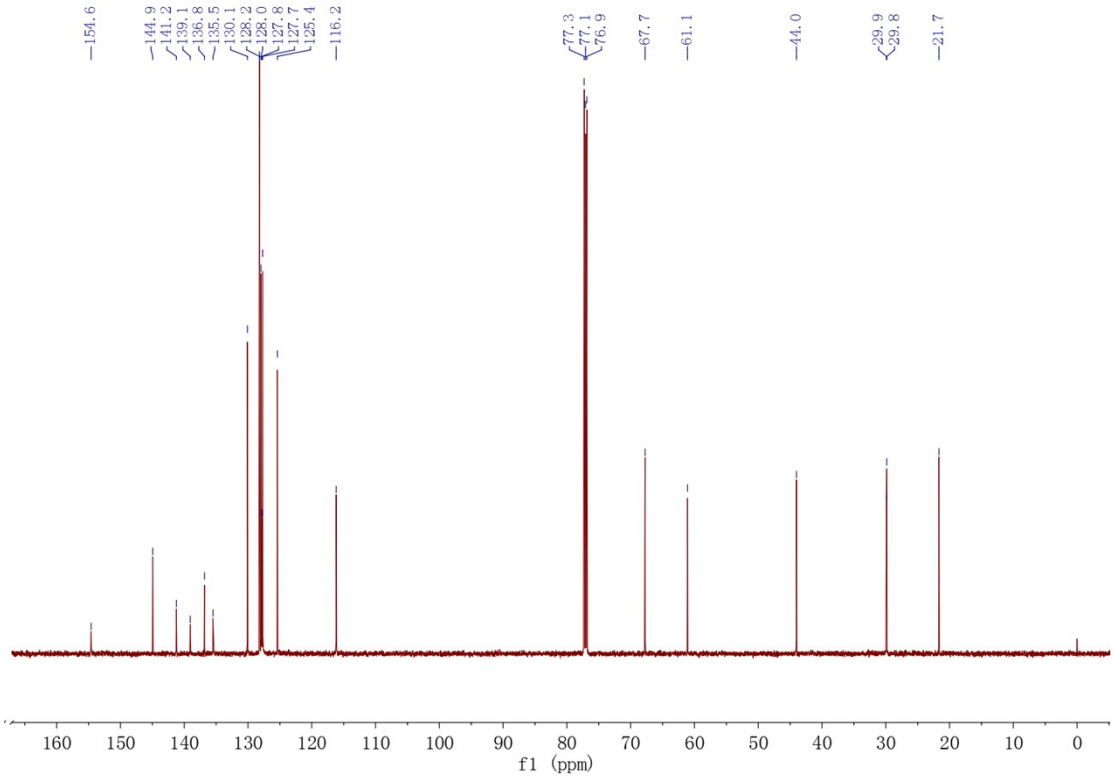

wpl1-h
7.45
7.44
7.41
7.39
7.38
7.36
7.35
7.26
7.23
7.21
7.21
7.20
7.18
7.18
7.17
7.17
5.99
4.29
3.69
3.24
3.22
3.20
2.63
2.61
2.59
2.39
2.20
2.18
1.66
2.10
1.90
2.02
1.06
6.05
1.05
1.00
1.00
2.08
1.03
1.06
3.24
1.05
3.12
f1 (ppm)

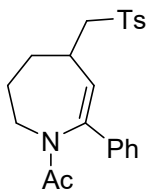

wpl1-c
171.79
144.72
144.37
141.53
139.17
138.14
129.79
128.60
127.65
77.27
77.05
76.84
65.94
42.71
40.79
37.98
25.27
21.56
f1 (ppm)


Ts
N
Ph
Cbz

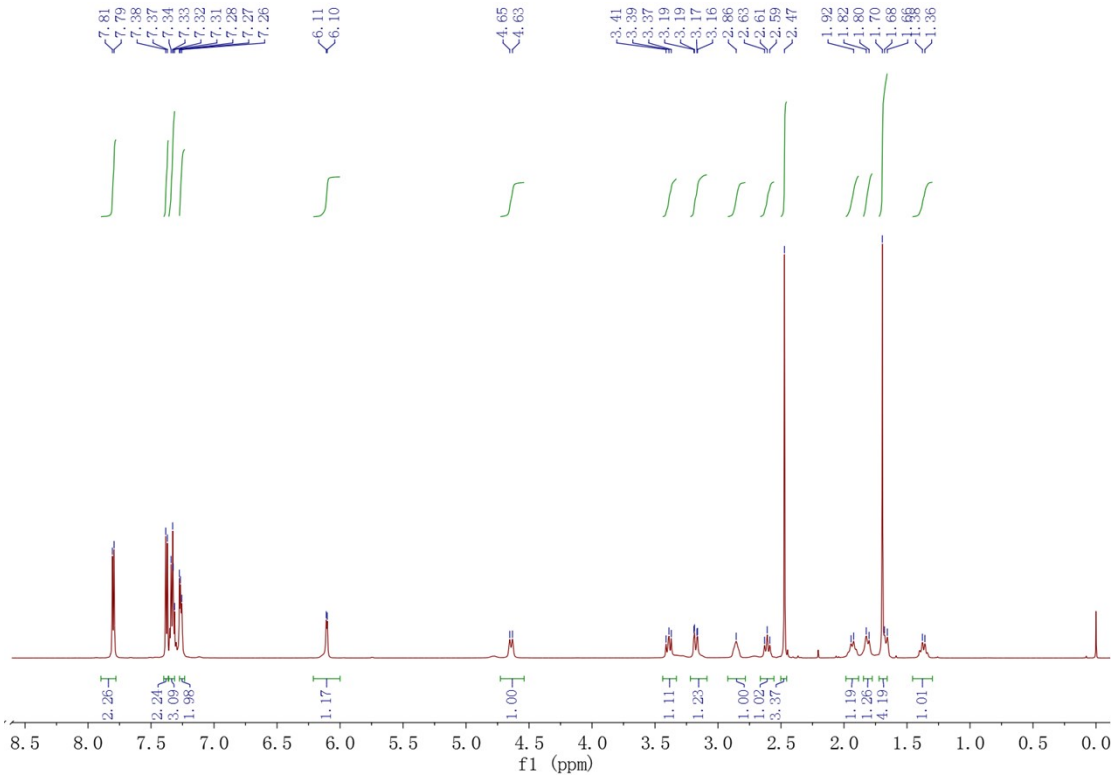
3t

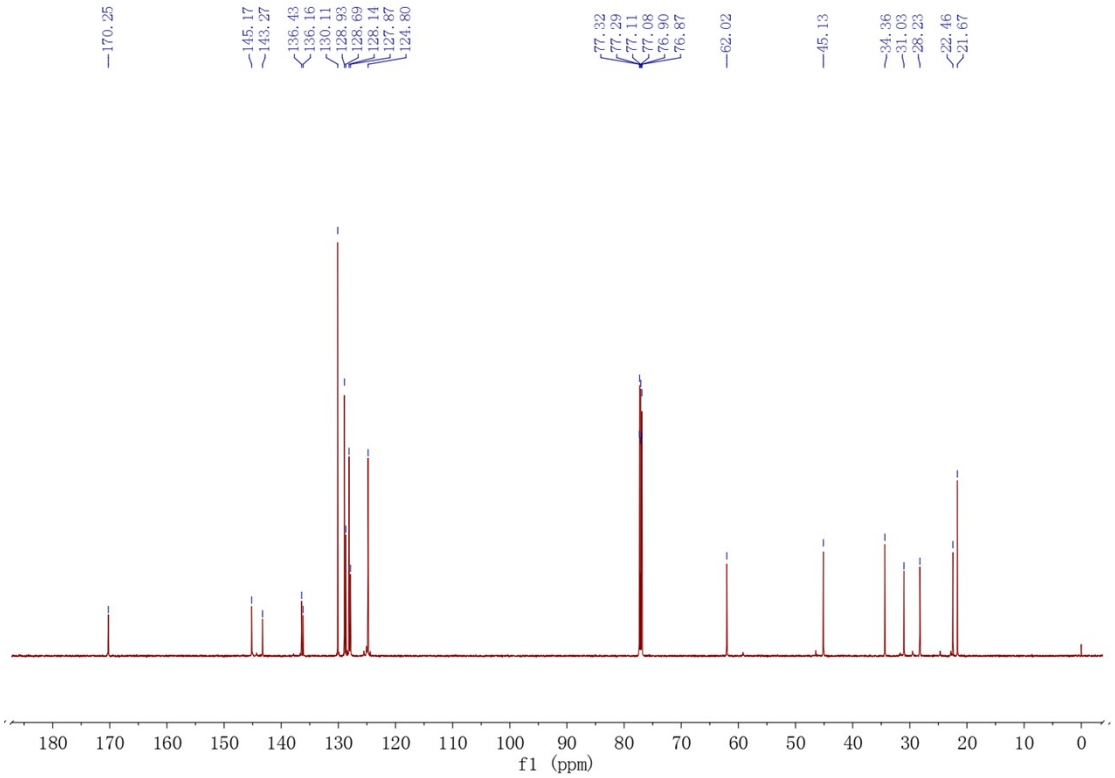

7.80
7.79
7.35
7.34
7.25
7.25
7.24
7.21
6.71
5.22
5.22
4.89
3.96
3.96
3.95
3.94
3.94
3.93
3.93
3.92
3.62
3.62
3.19
3.18
3.17
3.13
3.11
2.44
2.15
2.14
2.13
2.11
1.80
1.80
1.79
1.78
1.78
1.92
2.09
3.21
2.93
1.80
1.71
1.00
1.96
1.02
0.99
0.98
0.97
0.98
2.99
0.99
0.99
f1 (ppm)

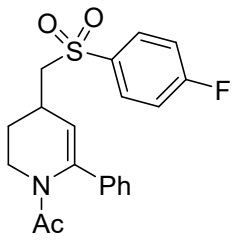

154.6
144.9
141.2
139.1
136.8
135.5
130.1
128.2
128.0
127.8
127.7
125.4
116.2
77.3
77.1
76.9
67.7
61.1
44.0
29.9
29.8
21.7
f1 (ppm)


Ts
N
Ac
Ph

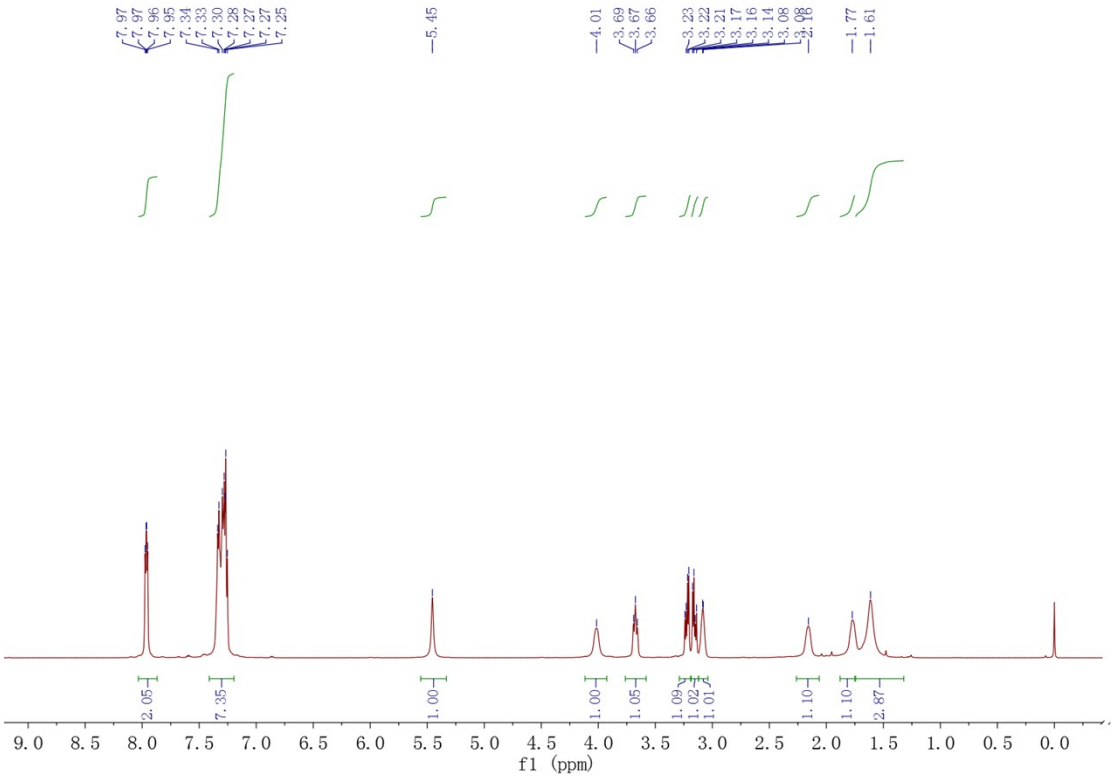
3u

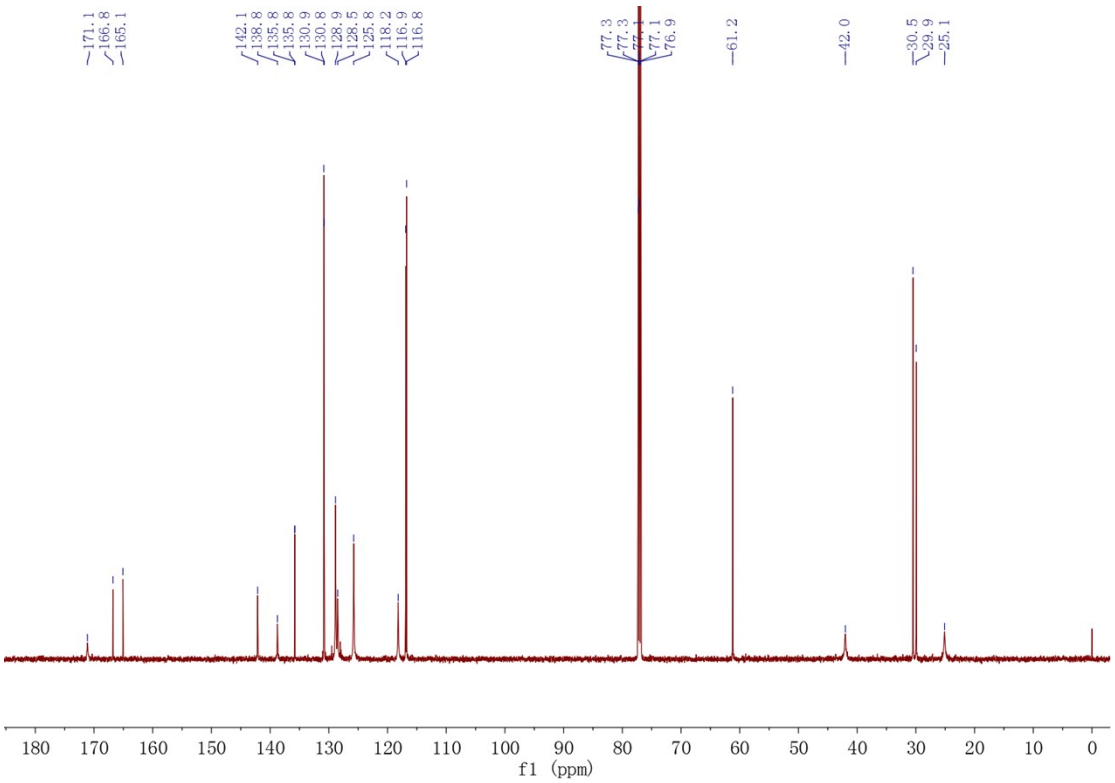

7.81
7.79
7.38
7.37
7.34
7.33
7.32
7.31
7.28
7.27
7.26
6.11
6.10
4.65
4.63
3.41
3.39
3.37
3.19
3.19
3.17
3.16
2.86
2.63
2.61
2.59
2.47
1.92
1.82
1.80
1.70
1.68
1.66
1.38
1.36
2.26
2.24
3.09
1.98
1.17
1.00
1.11
1.23
1.00
1.02
3.37
1.19
1.26
4.19
1.01
f1 (ppm)

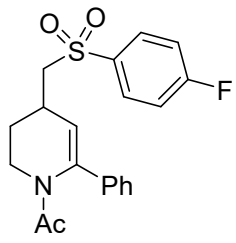

170.25
145.17
143.27
136.43
136.16
130.11
128.93
128.69
128.14
127.87
124.80
77.32
77.29
77.11
77.08
76.90
76.87
62.02
45.13
34.36
31.03
28.23
22.46
21.67
f1 (ppm)


O
O
S
F
N
Ph
Ac

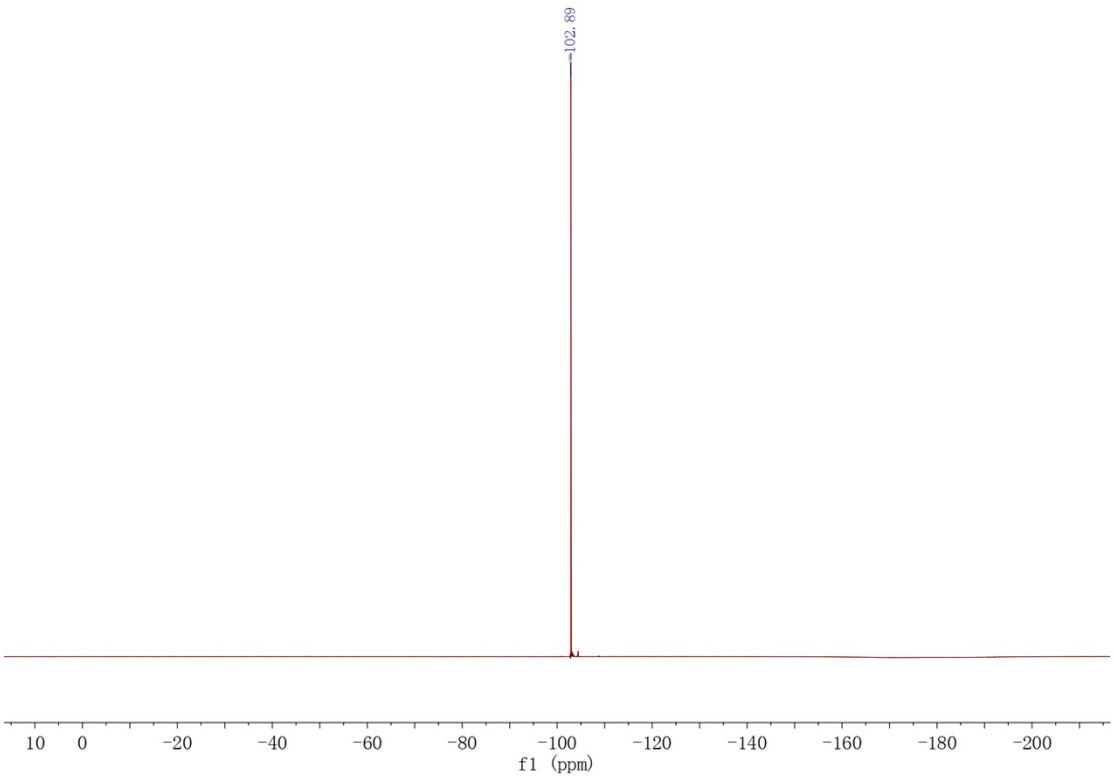
4a

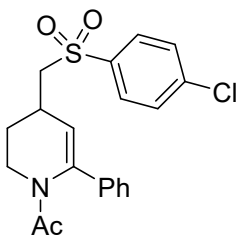

7.97
7.97
7.96
7.95
7.34
7.33
7.30
7.28
7.27
7.27
7.25
5.45
4.01
3.69
3.67
3.66
3.23
3.22
3.21
3.17
3.16
3.14
3.08
1.77
1.61
2.05
7.35
1.00
1.00
1.05
1.09
1.02
1.01
1.10
1.10
2.87
f1 (ppm)


171.1
166.8
165.1
142.1
138.8
135.8
135.8
130.9
130.8
128.9
128.5
125.8
118.2
116.9
116.8
77.3
77.3
77.1
76.9
61.2
42.0
30.5
29.9
25.1
f1 (ppm)

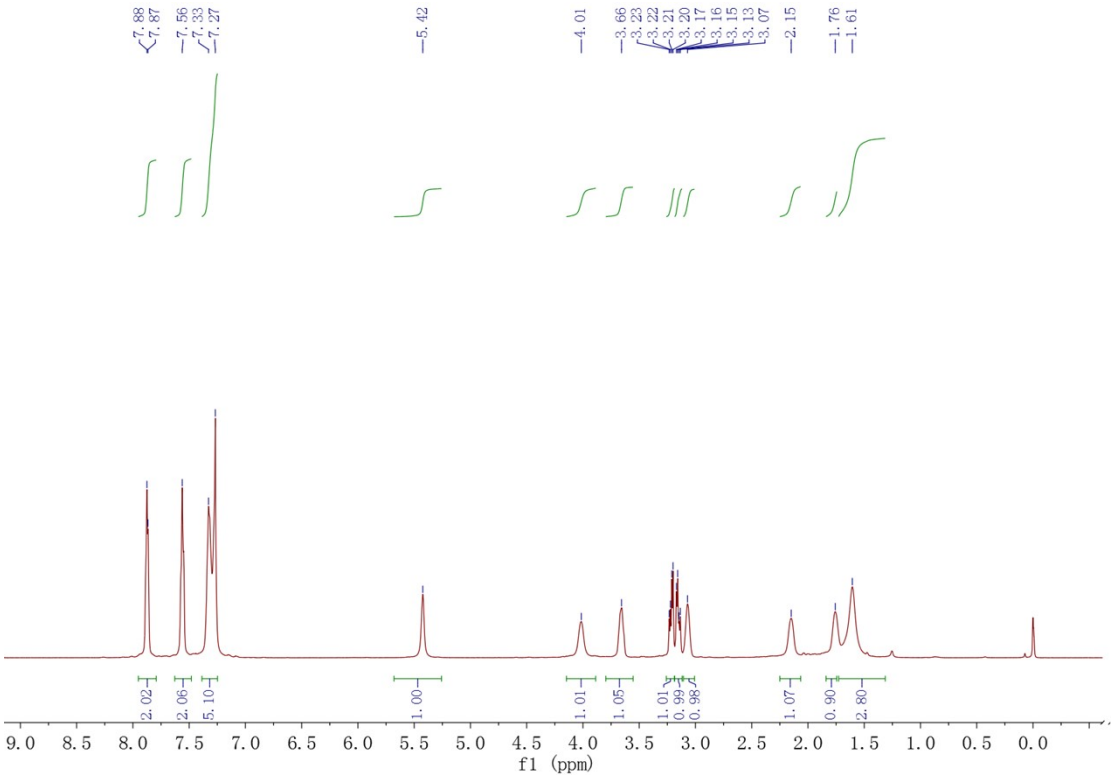

O
O
S
F
N
Ac
Ph

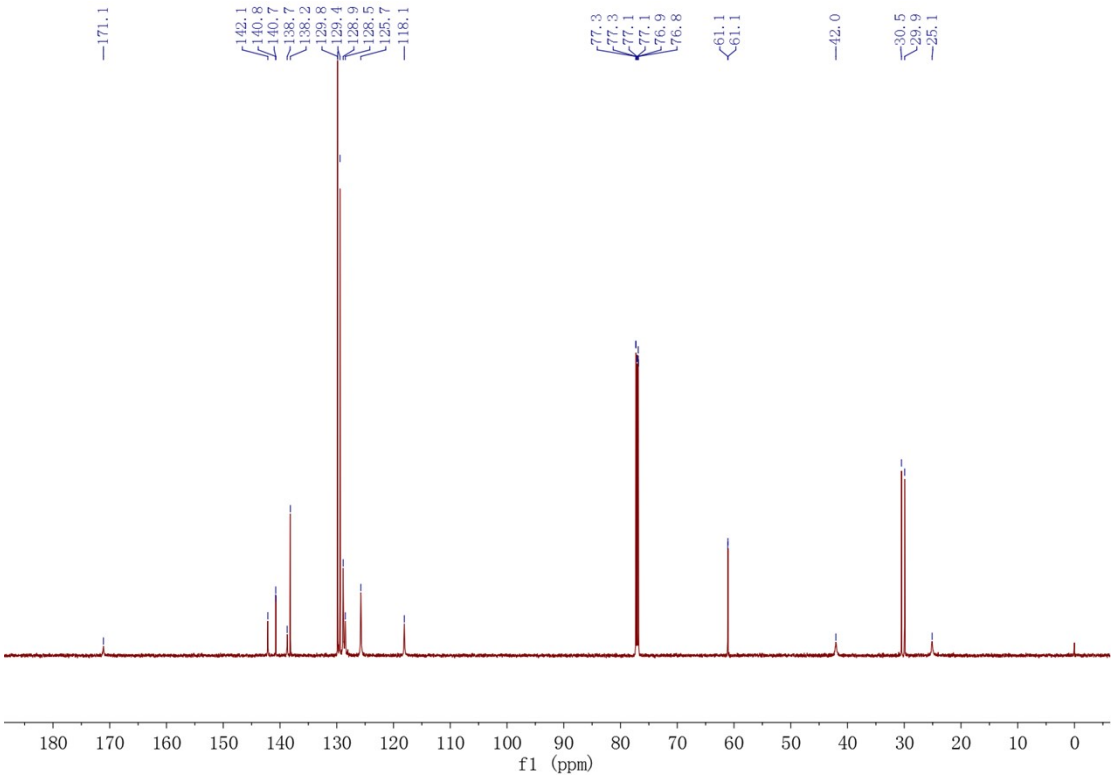
4a

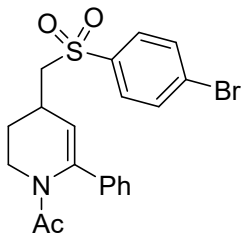




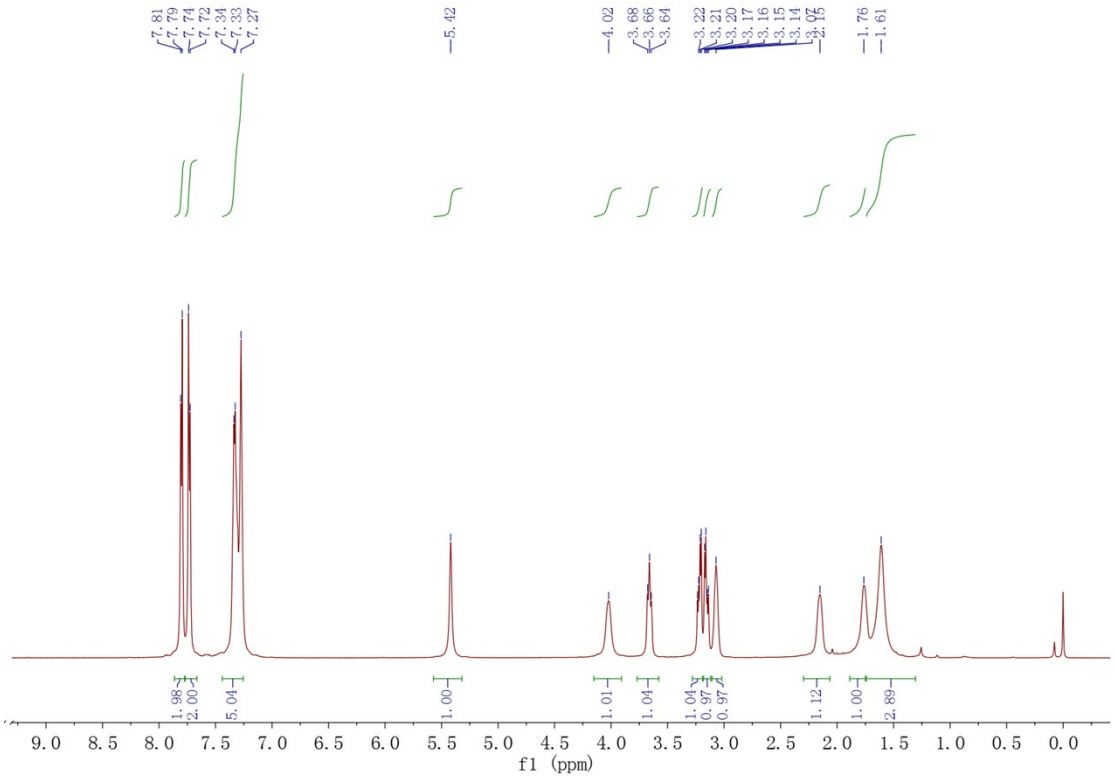
4b

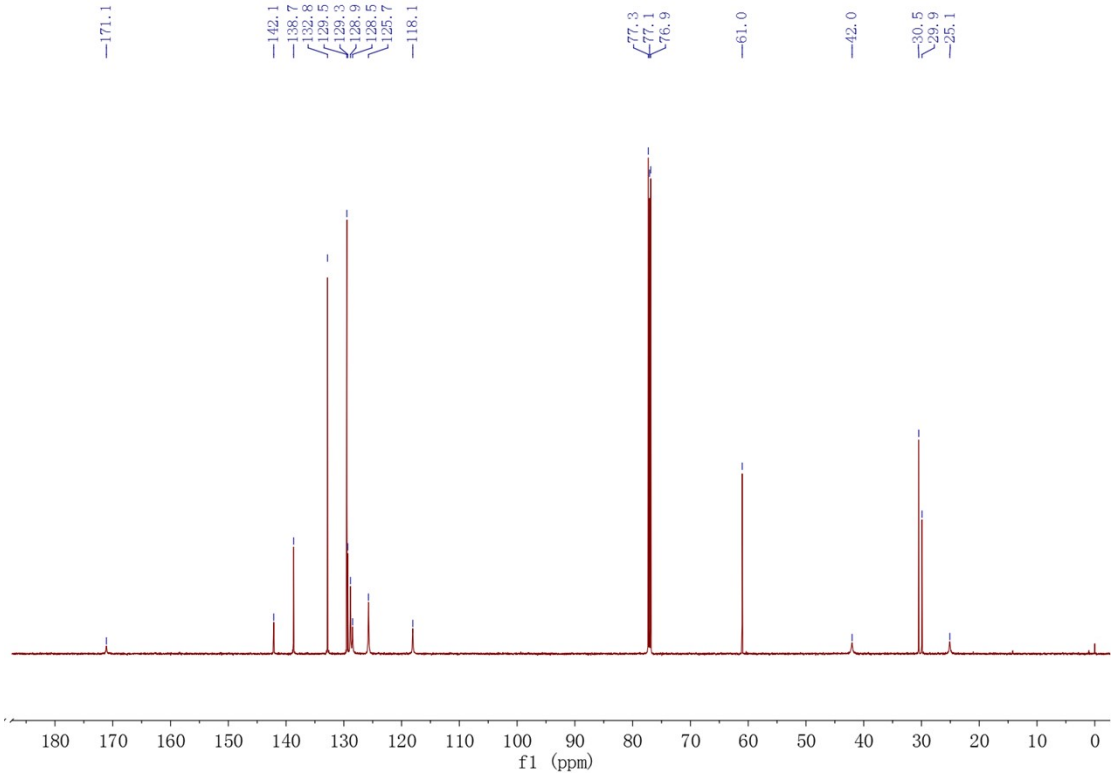

7.88
7.87
7.56
7.33
7.27
5.42
4.01
3.66
3.23
3.22
3.21
3.20
3.17
3.16
3.15
3.13
3.07
2.15
1.76
1.61
2.02
2.06
5.10
1.00
1.01
1.05
1.01
0.99
0.98
1.07
0.90
2.80
f1 (ppm)

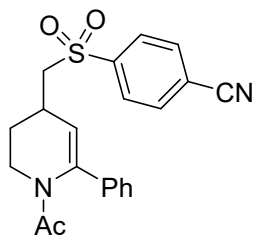

171.1
142.1
140.8
140.7
138.7
138.2
129.8
129.4
128.9
128.5
125.7
118.1
77.3
77.3
77.1
77.1
76.9
76.8
61.1
61.1
42.0
30.5
29.9
25.1
f1 (ppm)


O
O
S
Br
Ph
N
Ac

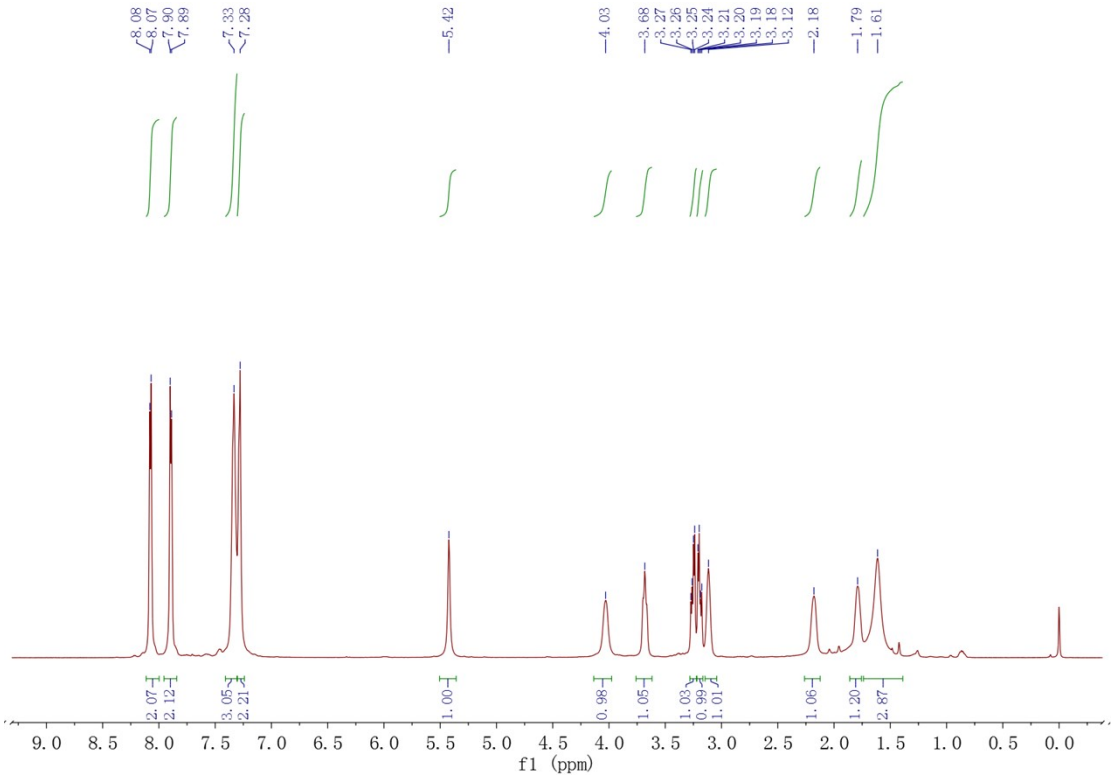
4c

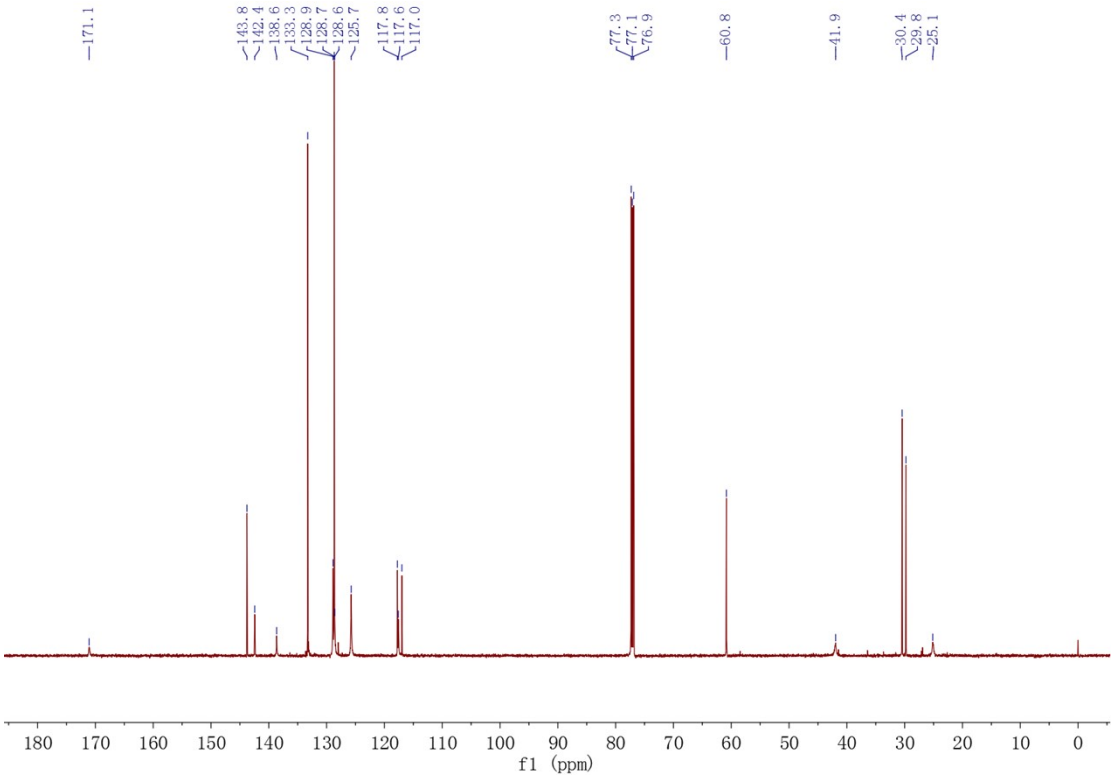

7.81
7.79
7.74
7.72
7.34
7.33
7.27
5.42
4.02
3.68
3.66
3.64
3.22
3.21
3.20
3.17
3.16
3.15
3.14
3.07
2.95
1.76
1.61
1.98
2.00
5.04
1.00
1.01
1.04
1.04
0.97
0.97
1.12
1.00
2.89
f1 (ppm)


171.1
142.1
138.7
132.8
129.5
129.3
128.9
128.5
125.7
118.1
77.3
77.1
76.9
61.0
42.0
30.5
29.9
25.1
f1 (ppm)


O
O
S
CN
N
Ac
Ph

4d


8.08
8.07
7.90
7.89
7.33
7.28
5.42
4.03
3.68
3.27
3.26
3.25
3.24
3.21
3.20
3.19
3.18
3.12
2.18
1.79
1.61
2.07
2.12
3.05
2.21
1.00
0.98
1.05
1.03
0.99
1.01
1.06
1.20
2.87
f1 (ppm)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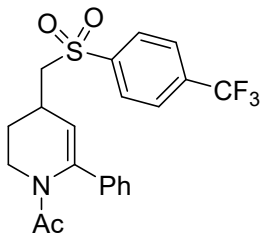
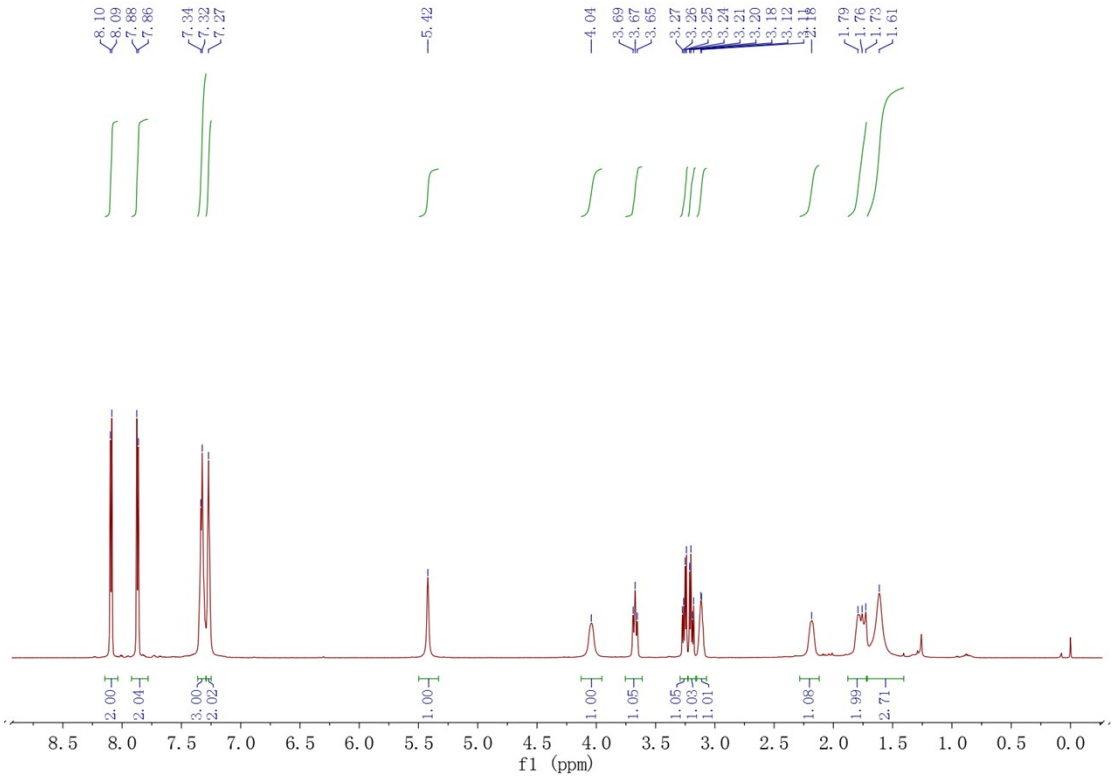
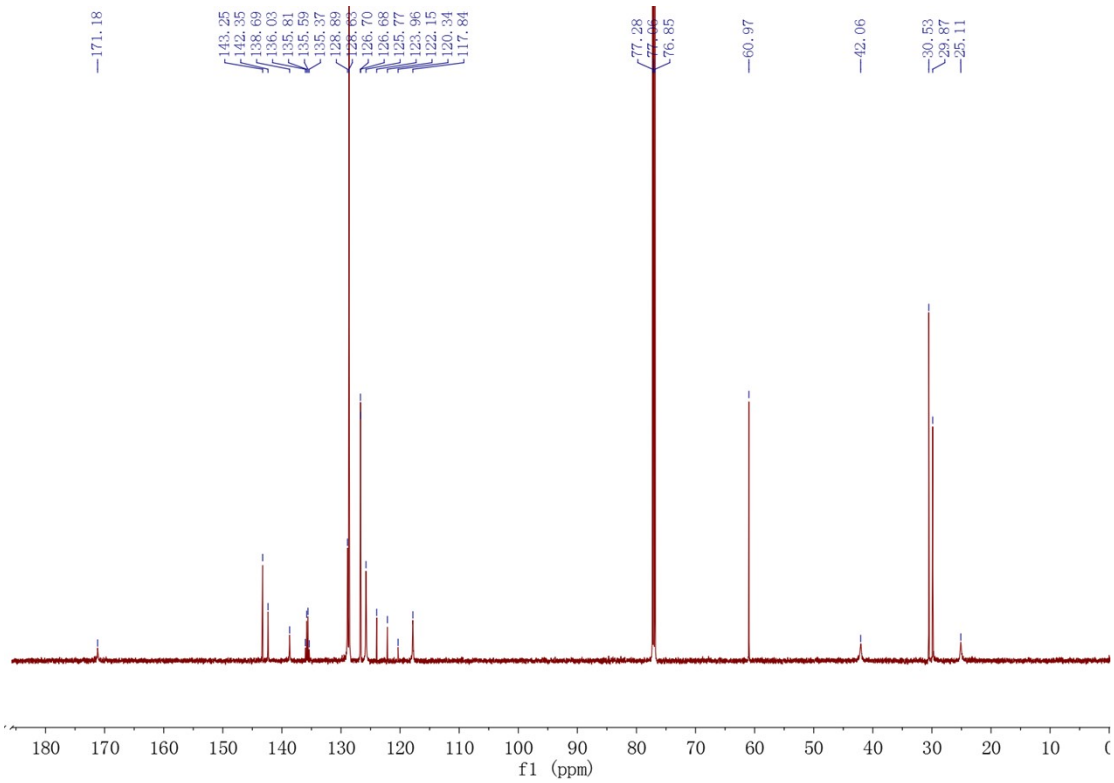
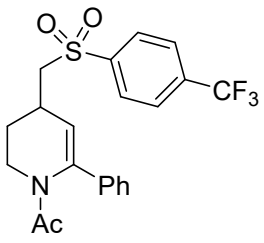
143.8
142.4
138.6
133.3
128.9
128.7
128.6
125.7
117.8
117.6
117.0
77.3
77.1
76.9
60.8
41.9
30.4
29.8
25.1
f1 (ppm)


O
O
S
CF3
N
Ac
Ph

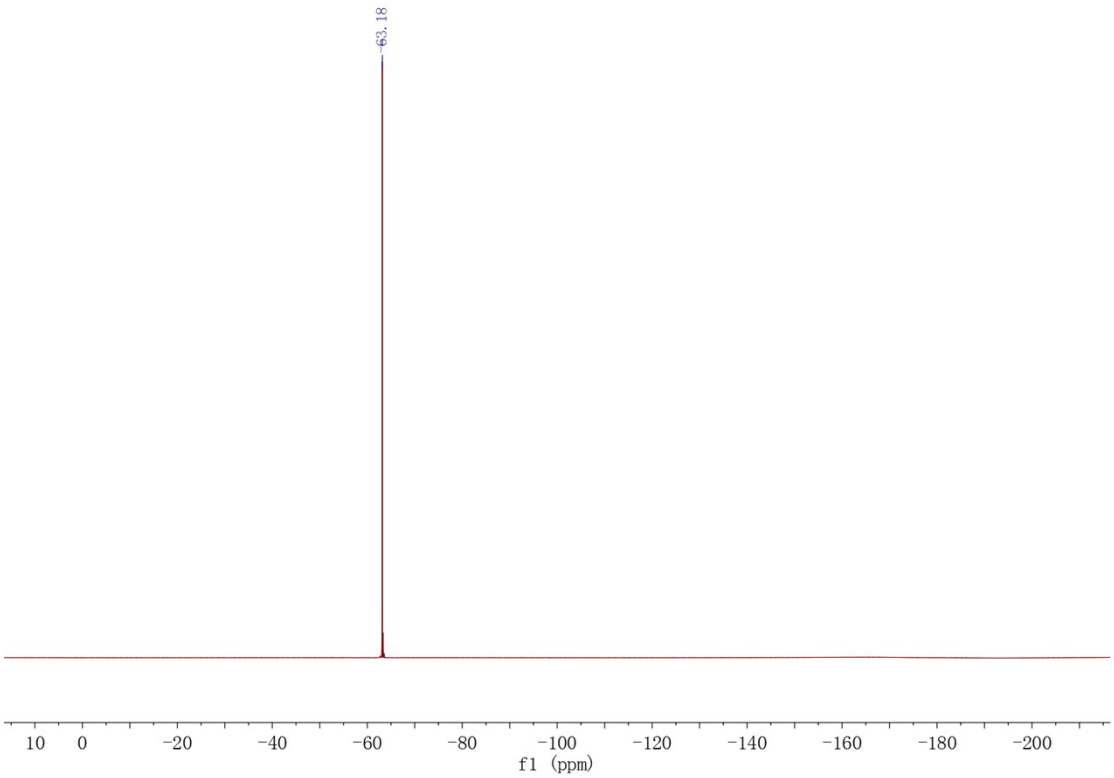
4e

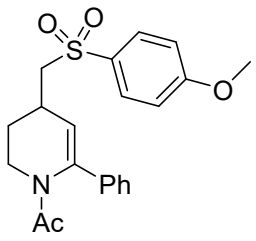

8.10
8.09
7.88
7.86
7.34
7.32
7.27
5.42
4.04
3.69
3.67
3.65
3.27
3.26
3.25
3.24
3.21
3.20
3.18
3.12
2.16
1.79
1.76
1.73
1.61
2.00
2.04
3.00
2.02
1.00
1.00
1.05
1.05
1.03
1.01
1.08
1.99
2.71
f1 (ppm)


171.18
143.25
142.35
138.69
136.03
135.81
135.59
135.37
128.89
128.63
126.70
126.68
125.77
123.96
122.15
120.34
117.84
77.28
77.06
76.85
60.97
42.06
30.53
29.87
25.11
f1 (ppm)

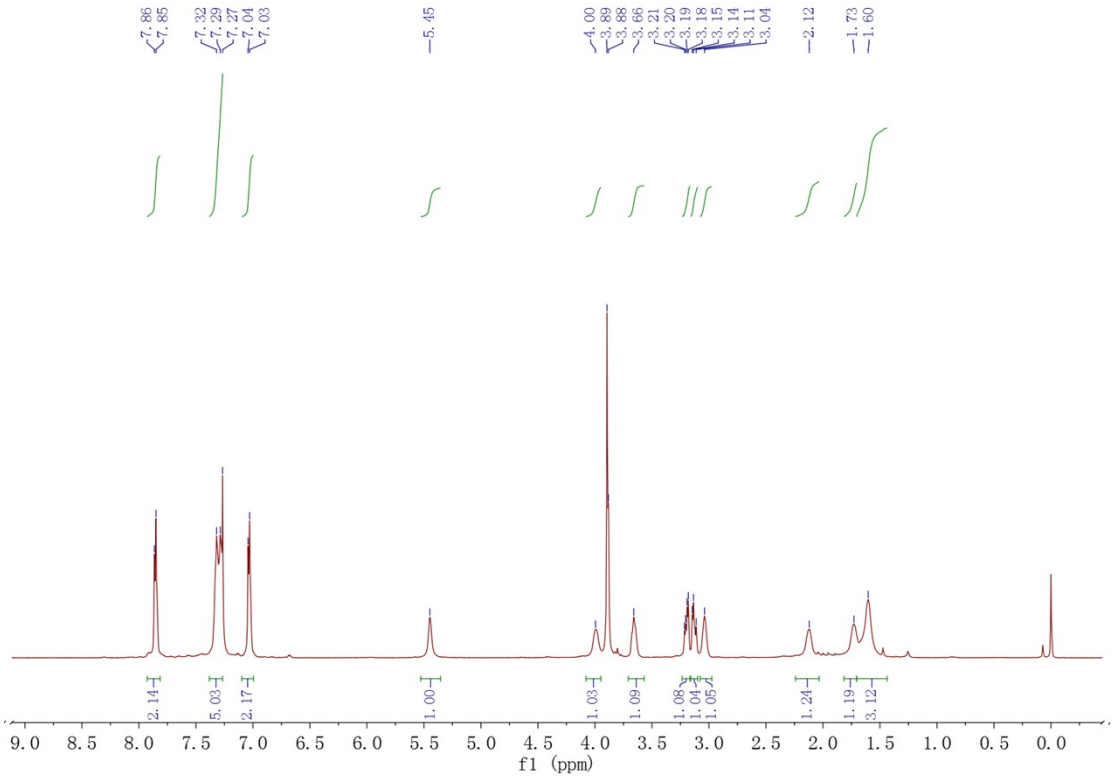

O
O
S
CF3
N
Ph
Ac

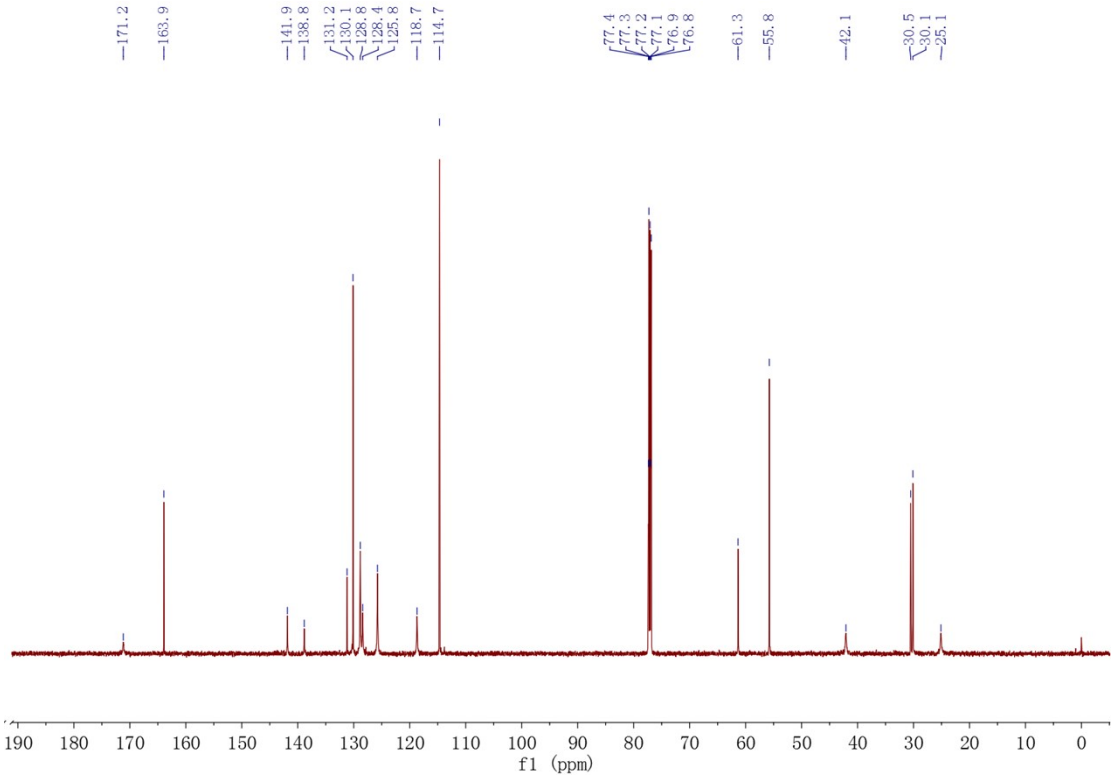
4e

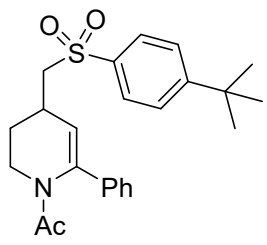




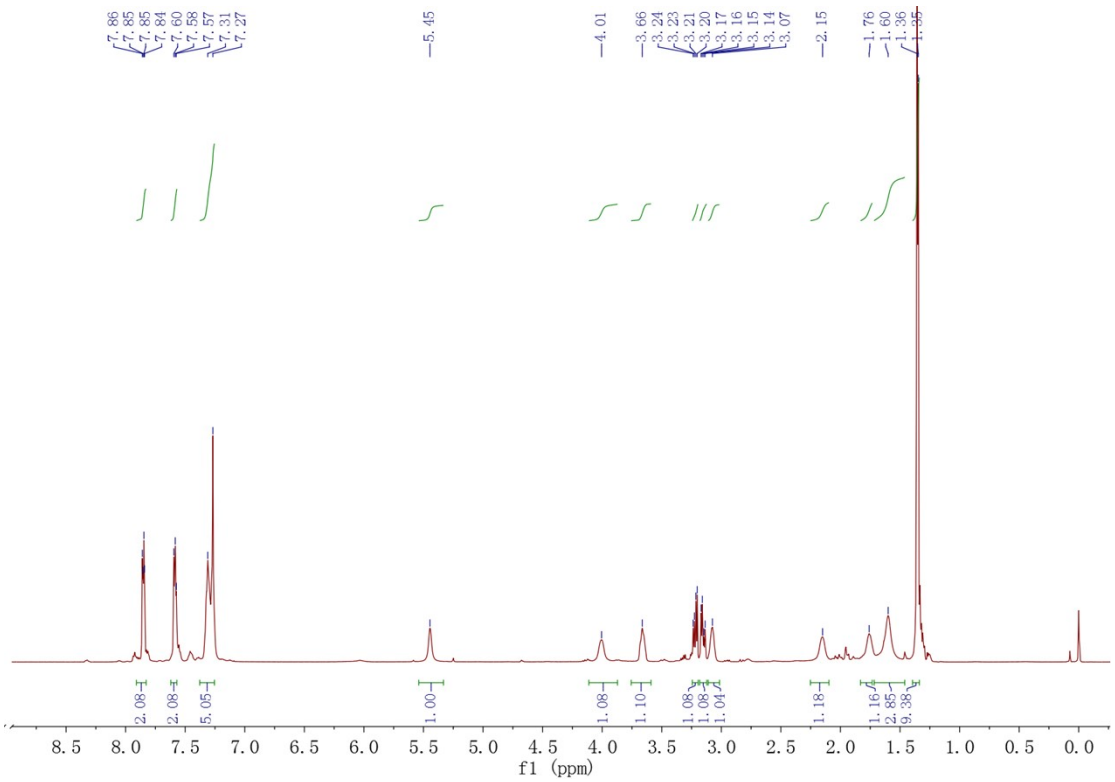
4f

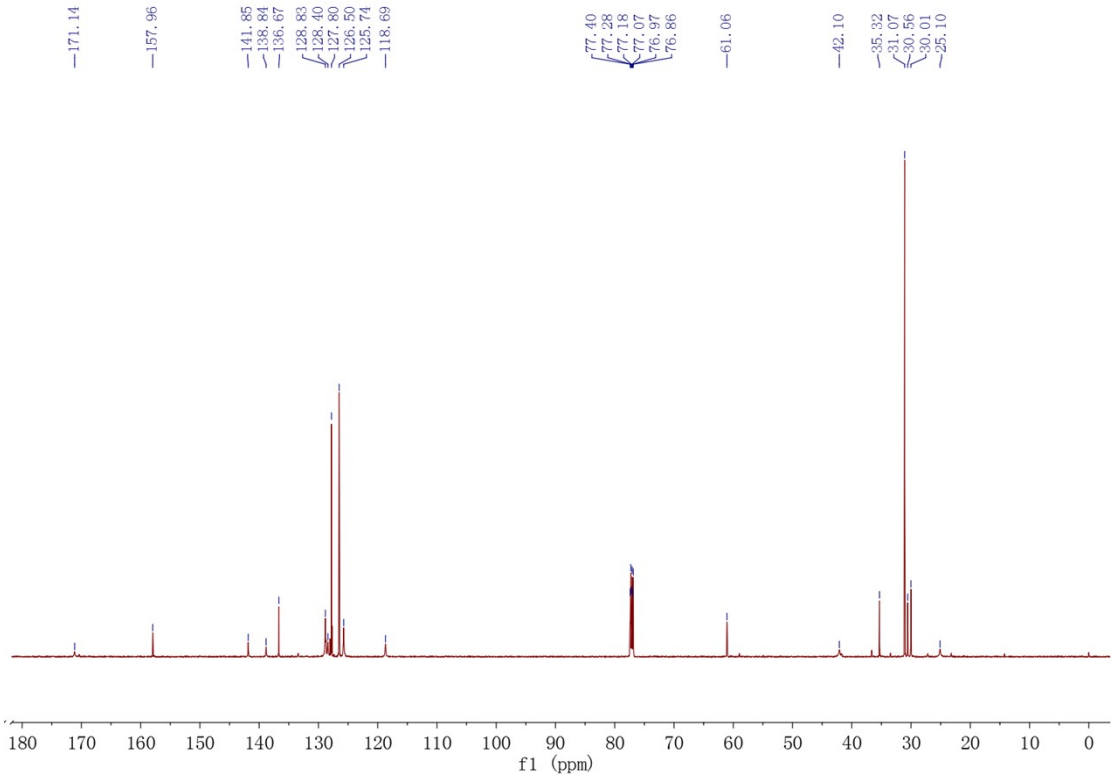

7.86
7.85
7.32
7.29
7.27
7.04
7.03
5.45
4.00
3.89
3.88
3.66
3.21
3.20
3.19
3.18
3.15
3.14
3.11
3.04
2.12
1.73
1.60
2.14
5.03
2.17
1.00
1.03
1.09
1.08
1.04
1.05
1.24
1.19
3.12
f1 (ppm)

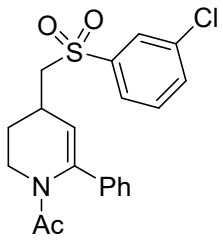

171.2
163.9
141.9
138.8
131.2
130.1
128.8
128.4
125.8
118.7
114.7
77.4
77.3
77.2
77.1
76.9
76.8
61.3
55.8
42.1
30.5
30.1
25.1
f1 (ppm)


O
O
S
N
Ph
Ac

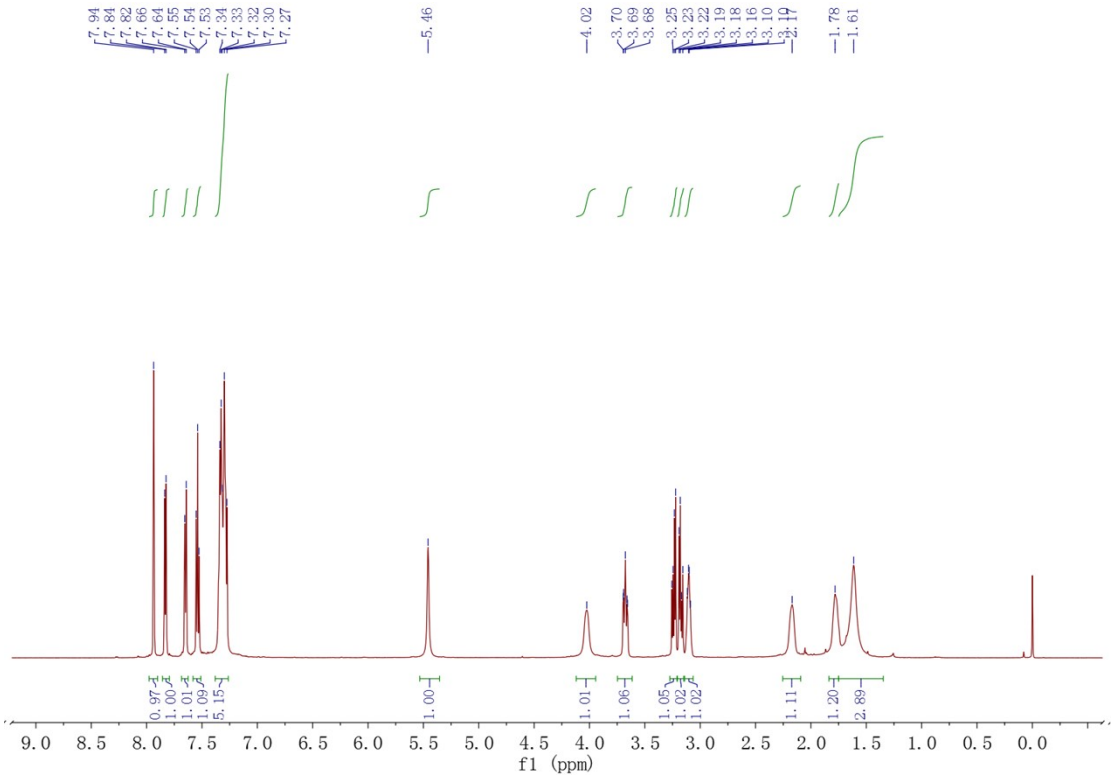
4g

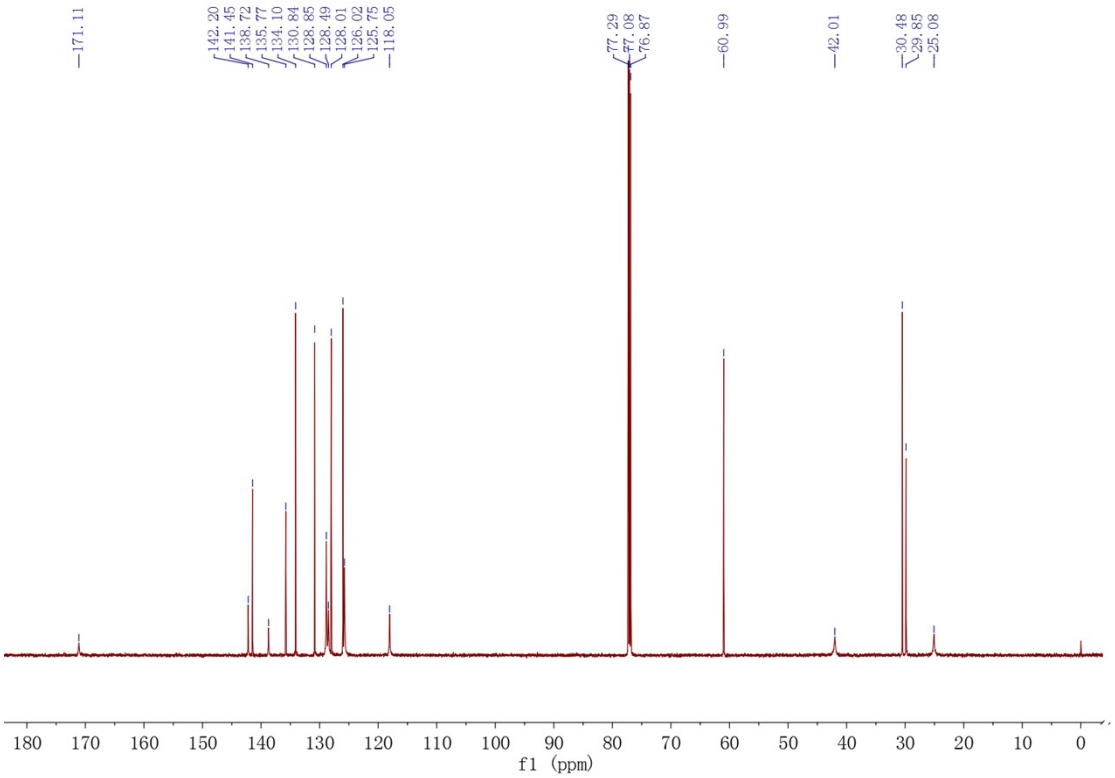

7.86
7.85
7.85
7.84
7.60
7.58
7.57
7.31
7.27
5.45
4.01
3.66
3.24
3.23
3.21
3.20
3.17
3.16
3.15
3.14
3.07
2.15
1.76
1.60
1.36
2.08
2.08
5.05
1.00
1.08
1.10
1.08
1.08
1.04
1.18
1.16
2.85
9.38
f1 (ppm)

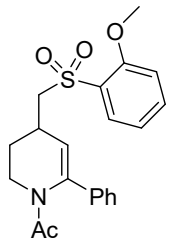

171.14
157.96
141.85
138.84
136.67
128.83
128.40
127.80
126.50
125.74
118.69
77.40
77.28
77.18
77.07
76.97
76.86
61.06
42.10
35.32
31.07
30.56
30.01
25.10
f1 (ppm)


O
O
S
Cl
N
Ph
Ac

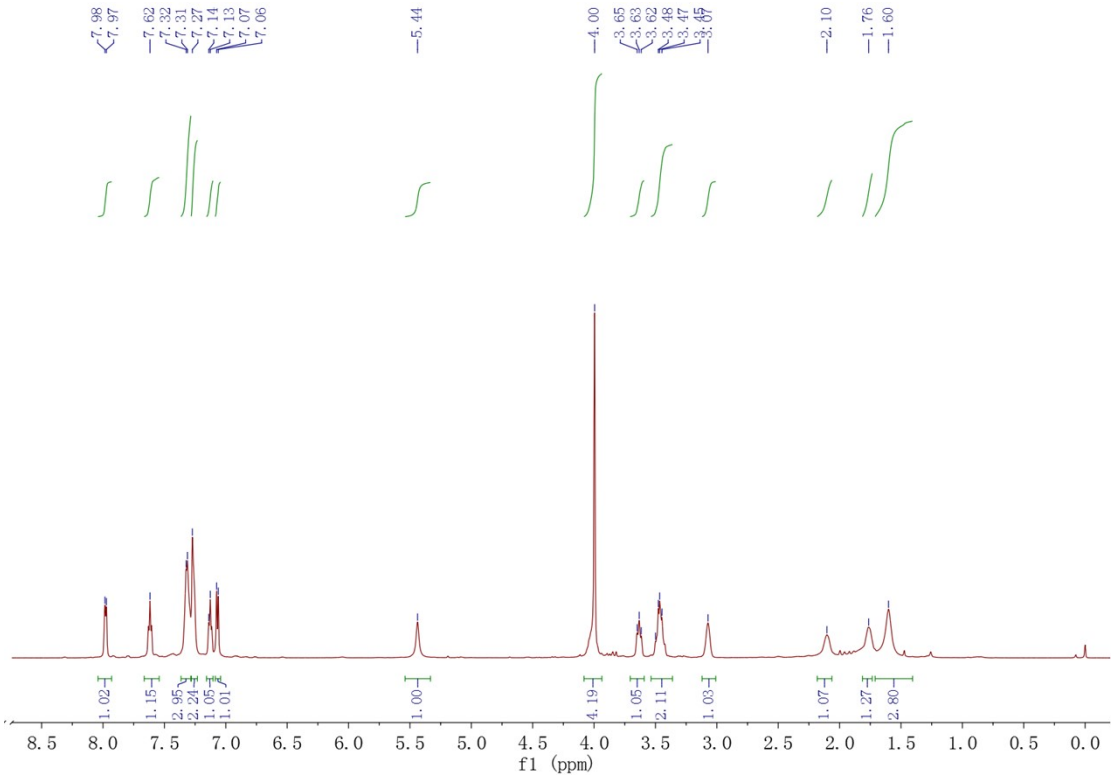
4h

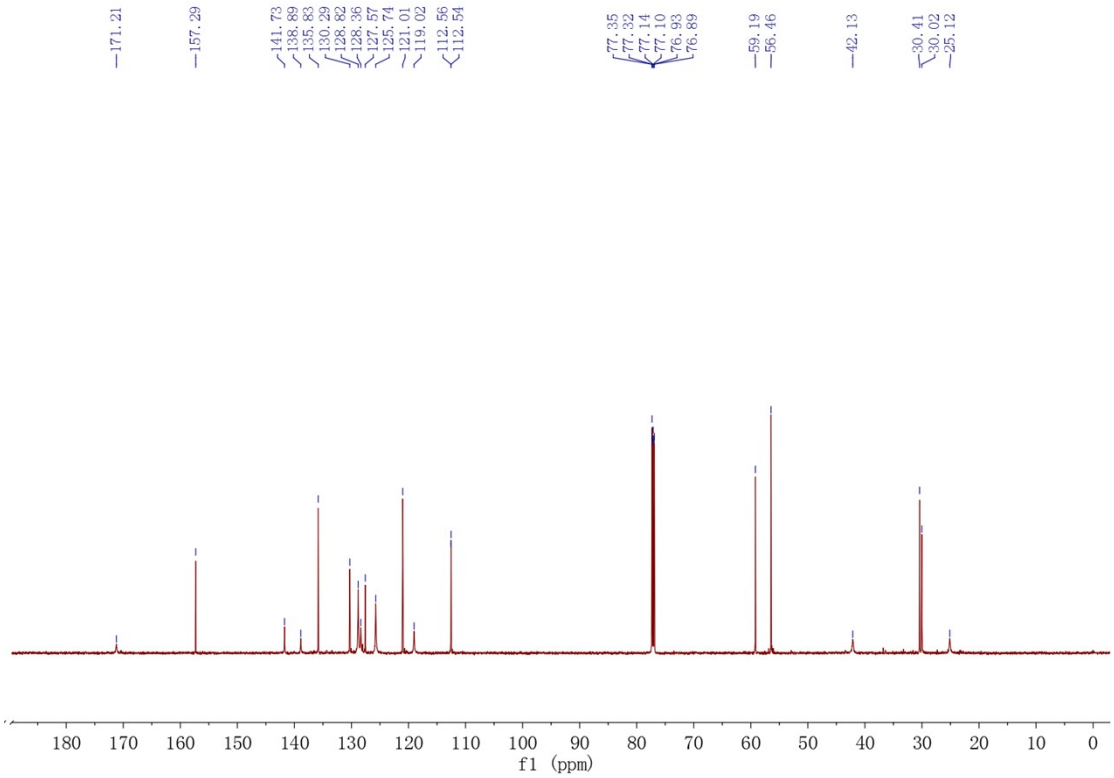

7.94
7.84
7.82
7.66
7.64
7.55
7.54
7.53
7.34
7.33
7.32
7.30
7.27
5.46
4.02
3.70
3.69
3.68
3.25
3.23
3.22
3.19
3.18
3.16
3.10
2.17
1.78
1.61
0.97
1.00
1.01
1.09
5.15
1.00
1.01
1.06
1.05
1.02
1.02
1.11
1.20
2.89
f1 (ppm)


171.11
142.20
141.45
138.72
135.77
134.10
130.84
128.85
128.49
128.01
126.02
125.75
118.05
77.29
77.08
76.87
60.99
42.01
30.48
29.85
25.08
f1 (ppm)


O
O
O
S
Ph
N
Ac

4i


7.98
7.97
7.62
7.32
7.31
7.27
7.14
7.13
7.07
7.06
5.44
4.00
3.65
3.63
3.62
3.48
3.47
3.45
3.07
2.10
1.76
1.60
1.02
1.15
2.95
2.24
1.05
1.01
1.00
4.19
1.05
2.11
1.03
1.07
1.27
2.80
f1 (ppm)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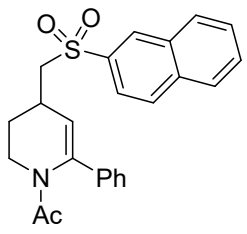
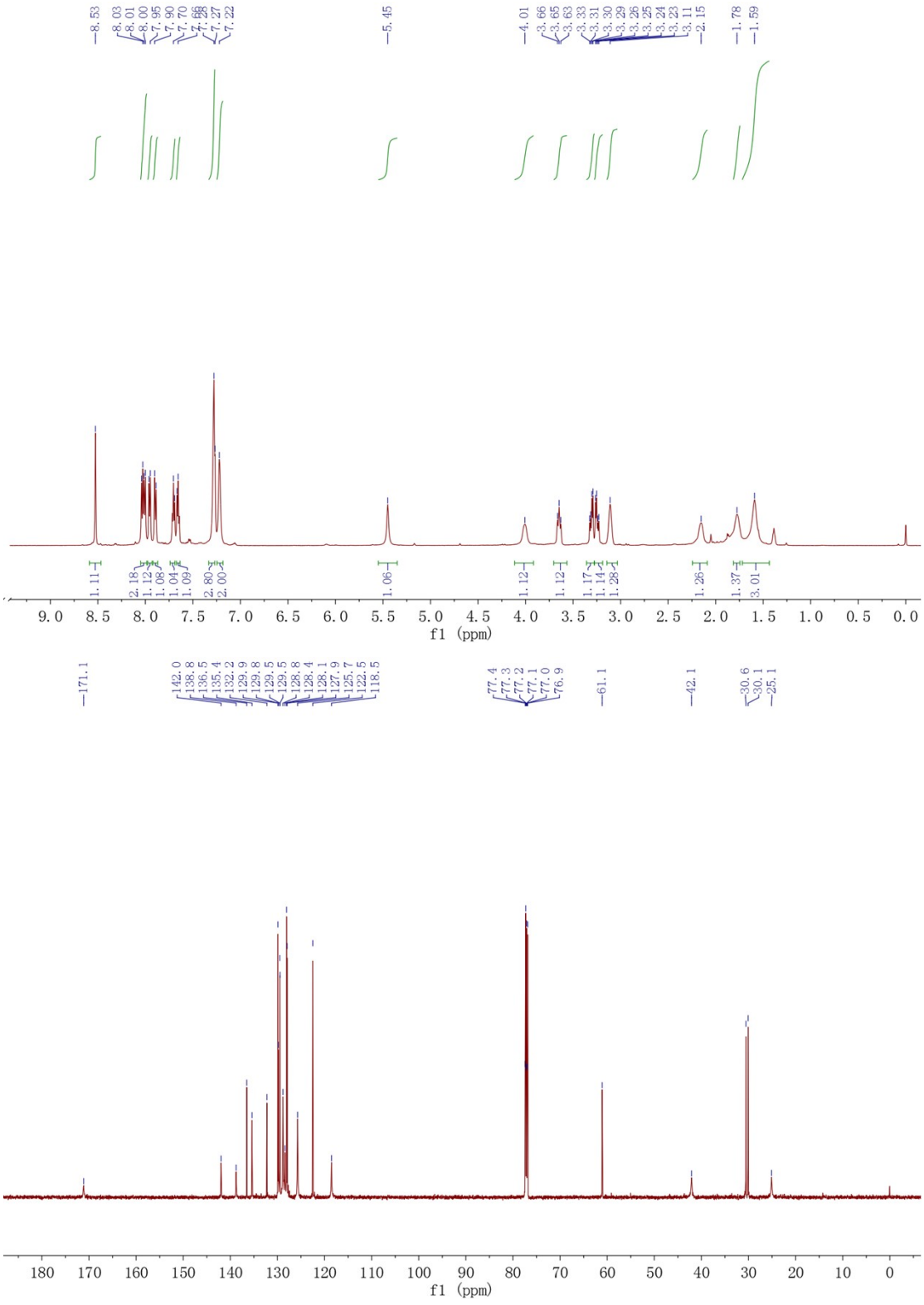
157.29
141.73
138.89
135.83
130.29
128.82
128.36
127.57
125.74
121.01
119.02
112.56
112.54
77.35
77.32
77.14
77.10
76.93
76.89
59.19
56.46
42.13
30.41
30.02
25.12
f1 (ppm)


O
O
S
N
Ph
Ac

4j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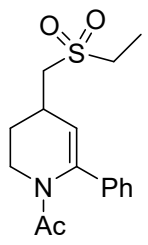
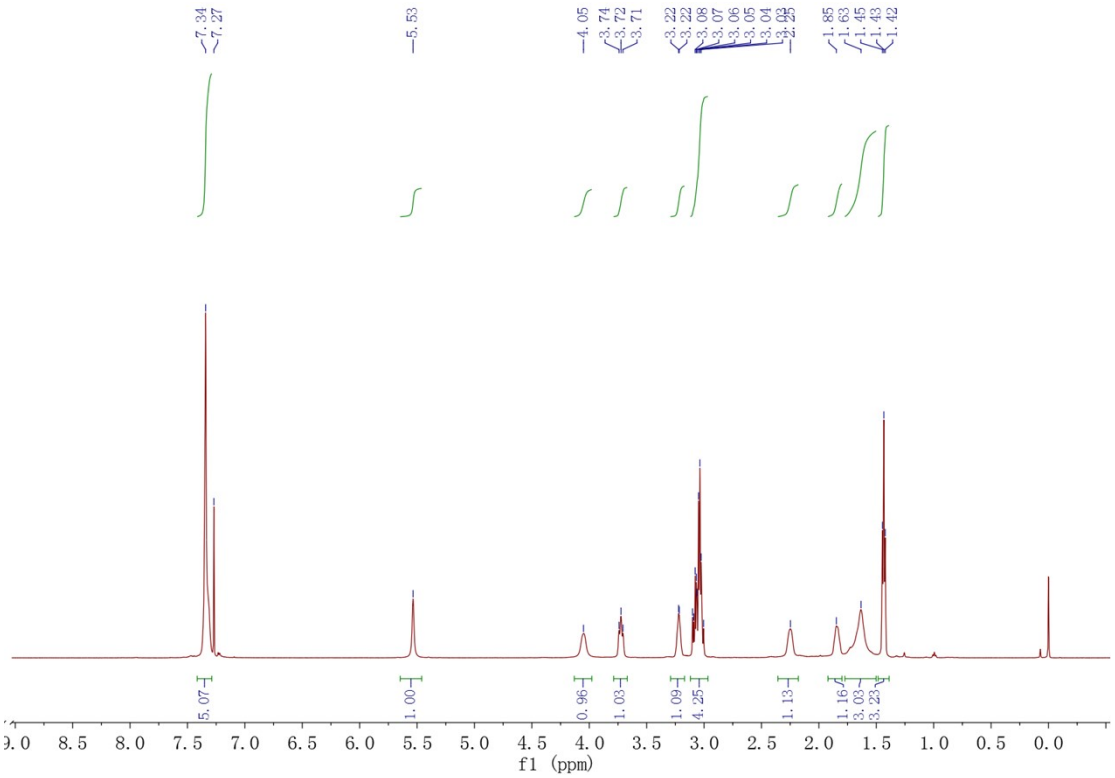
8.00
7.95
7.90
7.70
7.66
7.28
7.27
7.22
5.45
4.01
3.66
3.65
3.63
3.33
3.31
3.30
3.29
3.26
3.25
3.24
3.23
3.11
2.15
1.78
1.59
1.11
2.18
1.12
1.08
1.04
1.09
2.80
2.00
1.06
1.12
1.12
1.17
1.14
1.28
1.26
1.37
3.01
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)
171.1
142.0
138.8
136.5
135.4
132.2
129.9
129.8
129.5
129.5
128.8
128.4
128.1
127.9
125.7
122.5
118.5
77.4
77.3
77.2
77.1
77.0
76.9
61.1
42.1
30.6
30.1
25.1
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


O
O
S
N
Ph
Ac

4k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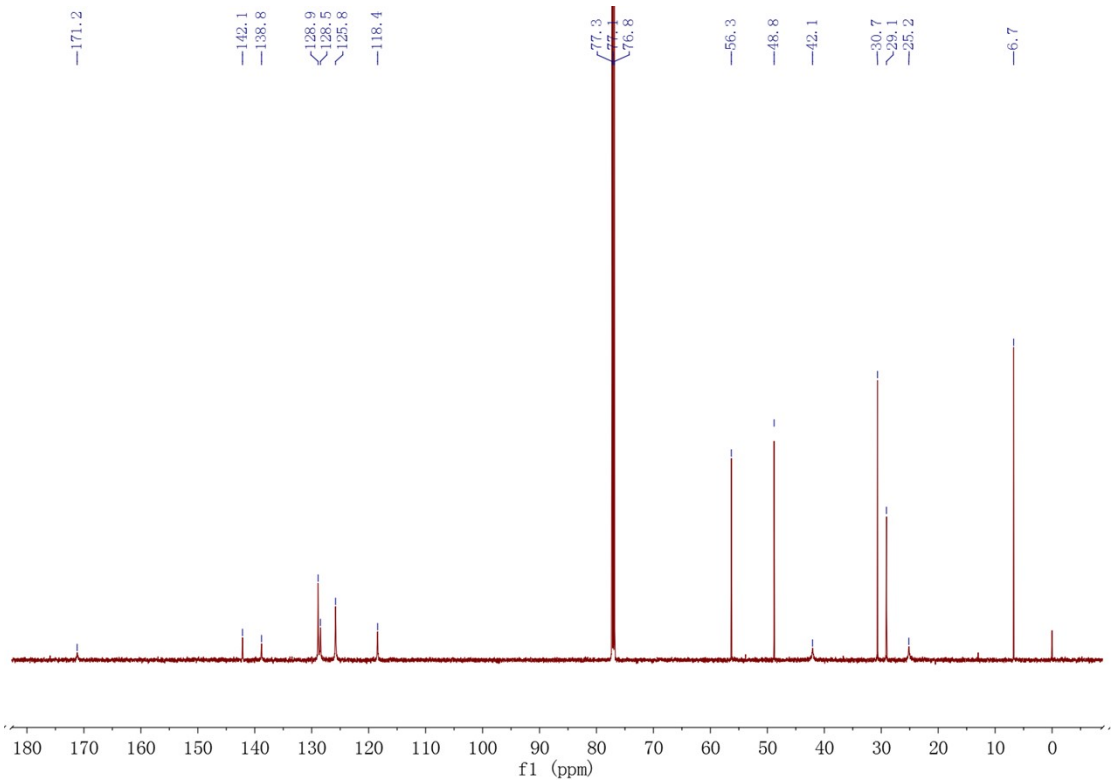
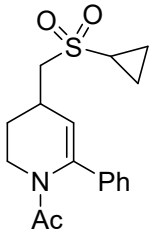
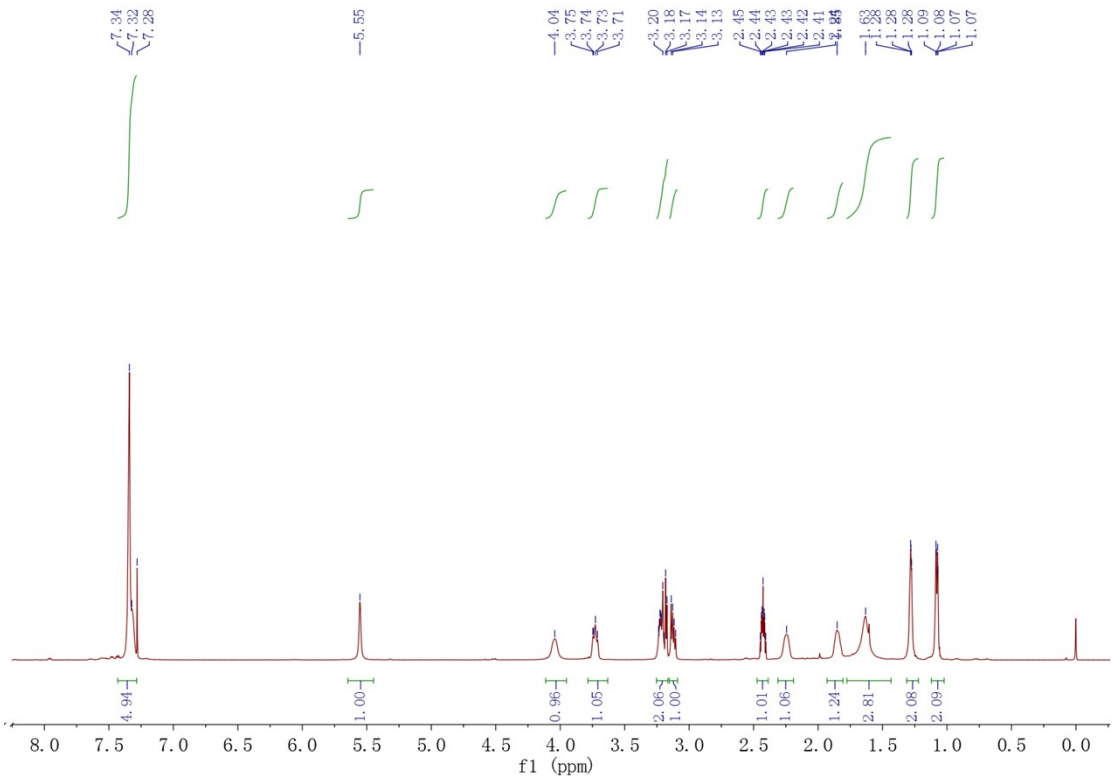
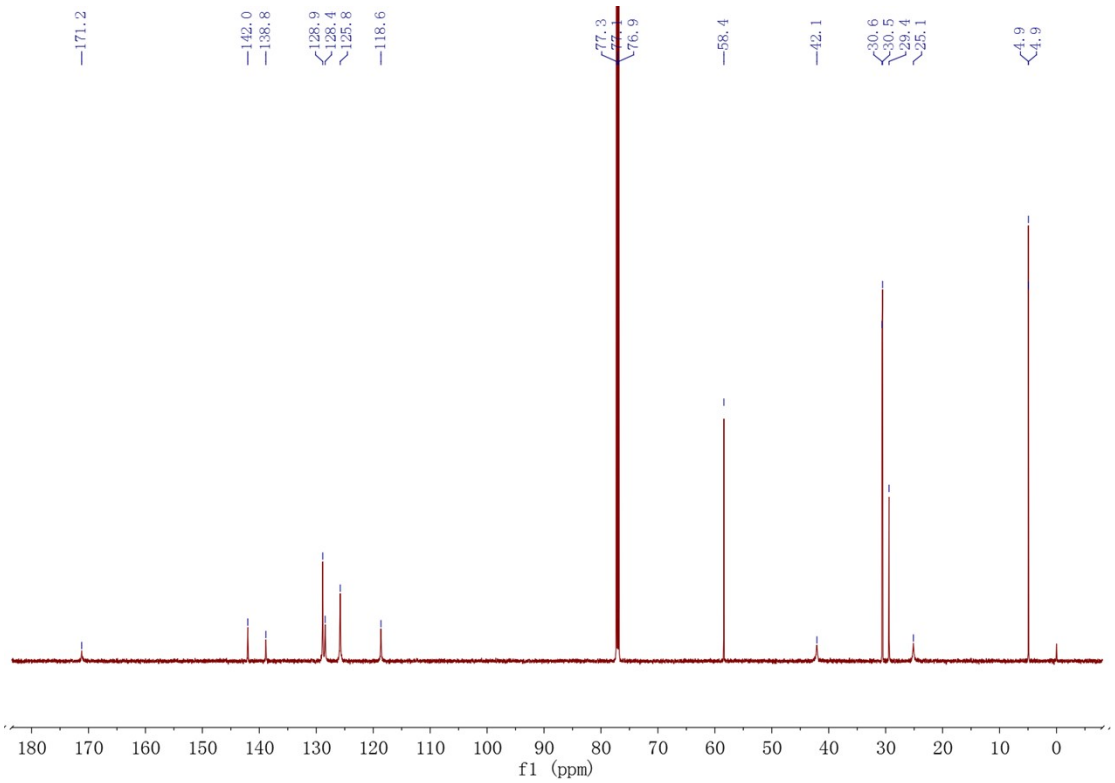
7.27
5.53
4.05
3.74
3.72
3.71
3.22
3.22
3.08
3.07
3.06
3.05
3.04
2.25
1.85
1.63
1.45
1.43
1.42
5.07
1.00
0.96
1.03
1.09
4.25
1.13
1.16
3.03
3.23
f1 (ppm)

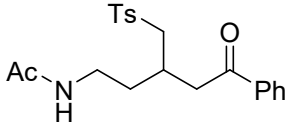

171.2
142.1
138.8
128.9
128.5
125.8
118.4
77.3
77.1
76.8
56.3
48.8
42.1
30.7
29.1
25.2
6.7
f1 (ppm)


O
O
S
N
Ac
Ph

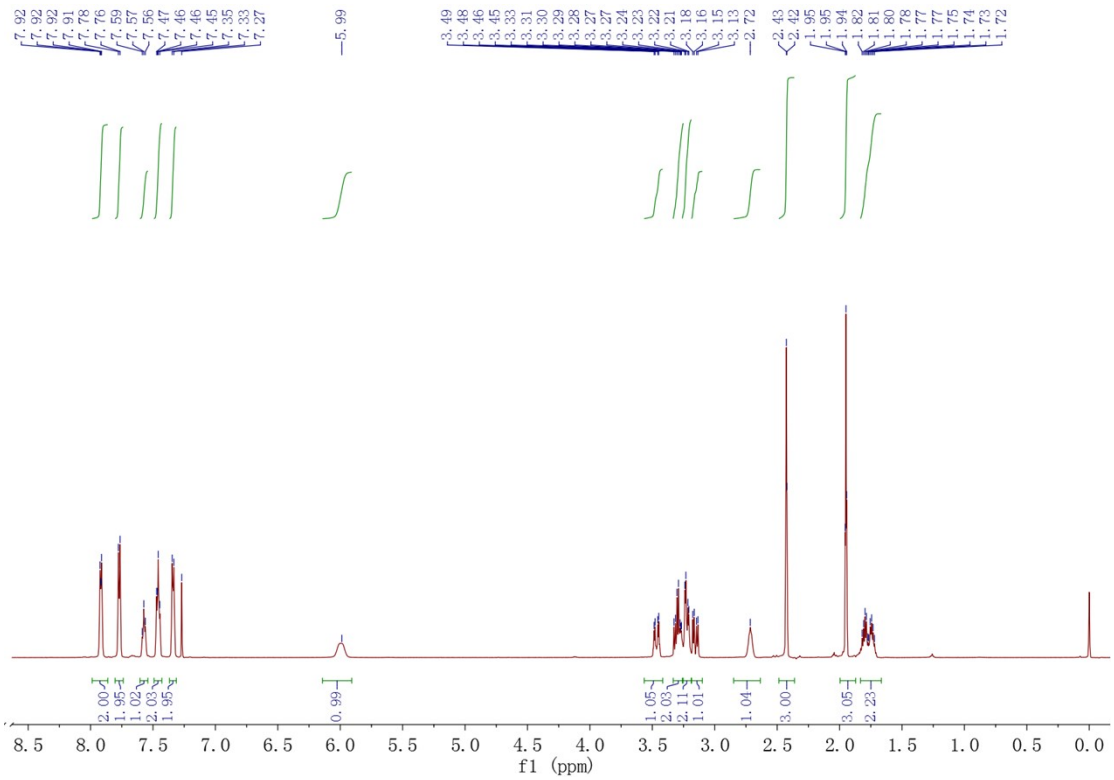
4l

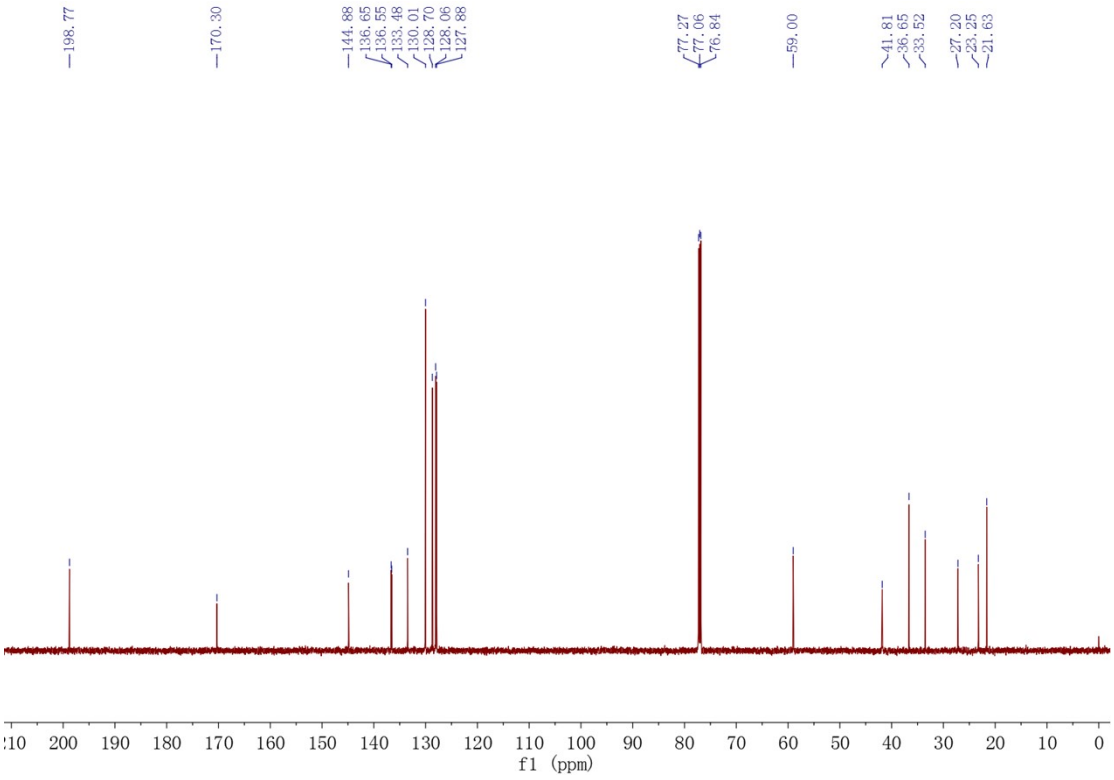

7.34
7.32
7.28
5.55
4.04
3.75
3.74
3.73
3.71
3.20
3.18
3.17
3.14
3.13
2.45
2.44
2.43
2.43
2.42
2.41
1.63
1.28
1.28
1.09
1.08
1.07
1.07
4.94
1.00
0.96
1.05
2.06
1.00
1.01
1.06
1.24
2.81
2.08
2.09
f1 (ppm)


171.2
142.0
138.8
128.9
128.4
125.8
118.6
77.3
77.1
76.9
58.4
42.1
30.6
30.5
29.4
25.1
4.9
4.9
f1 (ppm)


Ts
O
Ac
N
H
Ph

4aa


7.92 7.92 7.92 7.91 7.78 7.76 7.59 7.57 7.56 7.47 7.46 7.46 7.45 7.35 7.33 7.27
5.99
3.49 3.48 3.46 3.45 3.33 3.31 3.30 3.29 3.28 3.27 3.24 3.23 3.22 3.21 3.18 3.16 3.15 3.13
2.72
2.43 2.42 1.95 1.95 1.94 1.82 1.81 1.80 1.78 1.77 1.77 1.75 1.74 1.73 1.72
2.00 1.95 1.02 2.03 1.95
0.99
1.05 2.03 2.11 1.01
1.04
3.00
3.05 2.23
f1 (ppm)


198.77
170.30
144.88 136.65 136.55 133.48 130.01 128.70 128.06 127.88
77.27 77.06 76.84
59.00
41.81 36.65 33.52
27.20 23.25 21.63
f1 (ppm)