Supporting Information

Metal- and Base-Free Regioselective Cascade Sulfonylation-cyclization of 1,5-Dienes via the Insertion of Sulfur Dioxide: Access to Pyrrolines and Pyrrolinones

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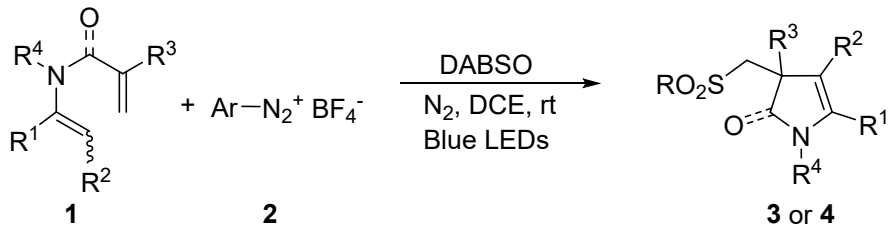
1. General information

Unless otherwise noted, all reagents and solvents were purchased from commercial suppliers and used without further purification. DABSO and solvents were purchased from Leyan company and used without further purification. Aiazonium salts were freshly prepared according to the literature.[2] ^{1}H-NMR and ^{13}C-NMR spectra were recorded at 25 ºC on Bruker Advance 600M or 400M NMR 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 WaterXEVOG2 Q-TOF (Waters Corporation). Flash chromatography was performed using 200-300 mesh silica gel with the indicated solvent system.

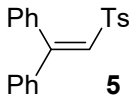
2. Procedure for the synthesis of compound 3a – 3p, 4a – 4l.



1 **2** **3** or **4**

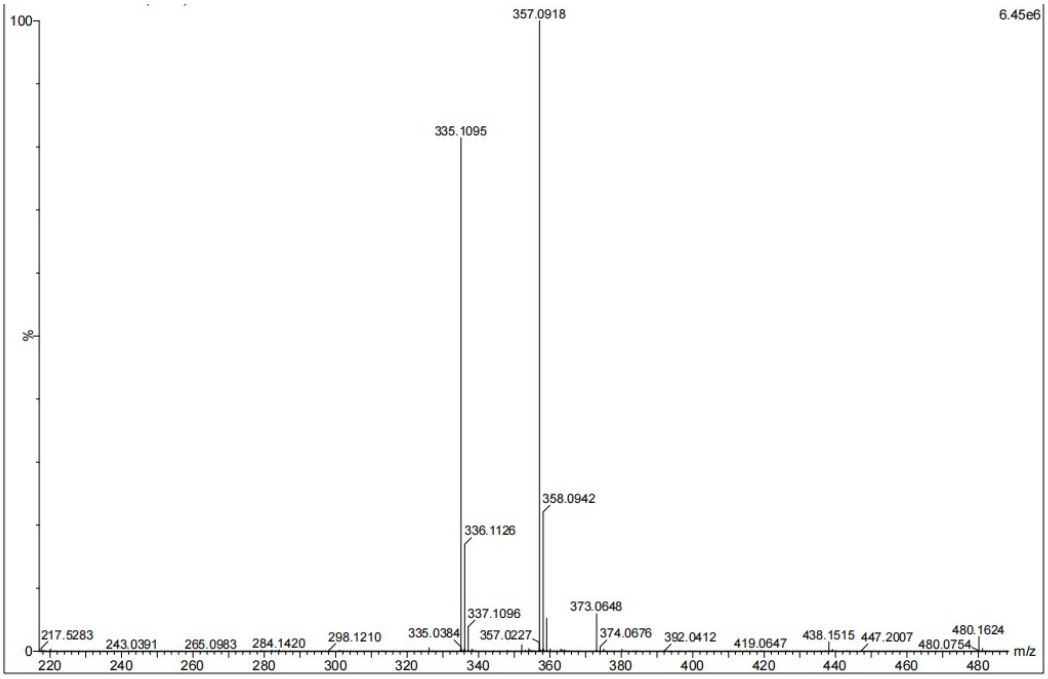
A dry 25-mL Schlenk tube containing a magnetic stirring bar was charged with 1,5-diene (0.1 mmol), aryldiazonium tetrafluoroborate (0.15 mmol), DABSO (0.12 mmol), and DCE (1mL). Then the mixture was charged with N_2 and irradiated with blue LEDs at room temperature for 12 h. After finishing, the reaction mixture was concentrated on a rotary evaporator and the residue was directly subjected to flash column chromatography on silica gel with (10-30% EtOAc/Petroleum ether) as eluate to furnish the desired product.

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



5

HRMS (ESI, m/z): Calcd. For $C_{21}H_{18}NSO_2Na$ $[M+Na]^+$ 357.0920, found: 357.0918.

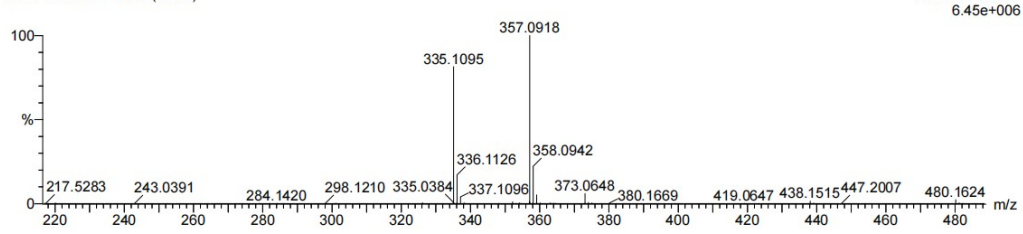


Elemental Composition Report **Page 1**

Single Mass Analysis
Tolerance = 10.0 PPM / DBE: min = -1.5, max = 50.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 3

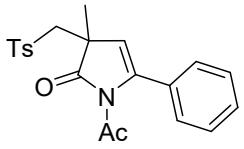
Monoisotopic Mass, Even Electron Ions
337 formula(e) evaluated with 1 results within limits (up to 50 closest results for each mass)
Elements Used:
C: 21-21 H: 0-30 N: 0-10 O: 0-20 S: 1-1 Na: 0-1

3
0307-4-RD-439-2 161 (0.909)
1: TOF MS ES+
6.45e+006



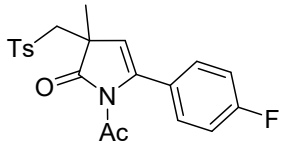
Minimum:				-1.5				
Maximum:		5.0	10.0	50.0				
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	Norm	Conf(%)	Formula
357.0918	357.0925	-0.7	-2.0	12.5	1125.4	n/a	n/a	C21 H18 O2 S Na

1-acetyl-3-methyl-5-phenyl-3-(tosylmethyl)-1H-pyrrol-2(3H)-one (3a)



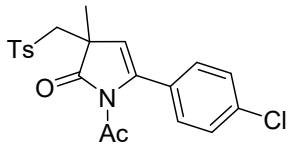
Known compound [1]. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.71 (d, *J* = 8.1 Hz, 2H), 7.41 – 7.28 (m, 4H), 5.51 (s, 1H), 3.69 (d, *J* = 14.4 Hz, 1H), 3.46 (d, *J* = 14.4 Hz, 1H), 2.49 (s, 3H), 2.42 (s, 3H), 1.39 (s, 3H). 13C NMR (151 MHz, CDCl3) δ 179.60, 169.23, 145.05, 142.88, 136.57, 132.68, 129.89, 128.50, 128.22, 127.88, 126.79, 115.54, 62.17, 47.77, 26.00, 24.57, 21.60.

1-acetyl-5-(4-fluorophenyl)-3-methyl-3-(tosylmethyl)-1H-pyrrol-2(3H)-one (3b)



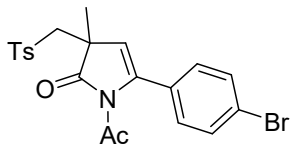
Known compound [1]. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.71 (d, *J* = 8.2 Hz, 2H), 7.29 (d, *J* = 8.0 Hz, 2H), 7.24 (dd, *J* = 8.6, 5.3 Hz, 2H), 7.05 (t, *J* = 8.6 Hz, 2H), 5.53 (s, 1H), 3.68 (d, *J* = 14.3 Hz, 1H), 3.45 (d, *J* = 14.3 Hz, 1H), 2.50 (s, 3H), 2.43 (s, 3H), 1.39 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 179.56, 169.32, 162.72 (*J* = 252 Hz), 145.14, 142.02, 136.61, 129.93, 128.84, 128.78, 128.14, 115.65, 115.02, 114.88, 62.21, 47.68, 26.05, 24.53, 21.62. ^{19}F NMR (565 MHz, $CDCl_3$) δ -112.68.

1-acetyl-5-(4-chlorophenyl)-3-methyl-3-(tosylmethyl)-1H-pyrrol-2(3H)-one (3c)



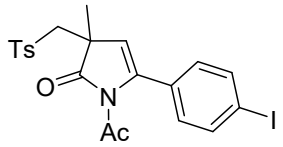
Known compound [1]. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.70 (d, *J* = 8.1 Hz, 2H), 7.33 (d, *J* = 8.4 Hz, 2H), 7.29 (d, *J* = 8.1 Hz, 2H), 7.19 (d, *J* = 8.4 Hz, 2H), 5.56 (s, 1H), 3.68 (d, *J* = 14.3 Hz, 1H), 3.45 (d, *J* = 14.3 Hz, 1H), 2.50 (s, 3H), 2.43 (s, 3H), 1.39 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 179.46, 169.26, 145.16, 141.91, 136.56, 134.40, 131.26, 129.95, 128.24, 128.13, 128.13, 116.05, 62.20, 47.75, 25.97, 24.48, 21.62.

1-acetyl-5-(4-bromophenyl)-3-methyl-3-(tosylmethyl)-1H-pyrrol-2(3H)-one (3d)



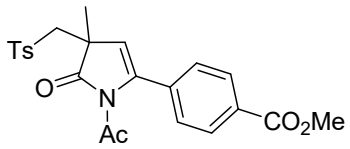
Known compound [1]. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.70 (d, *J* = 8.1 Hz, 2H), 7.48 (d, *J* = 8.3 Hz, 2H), 7.29 (d, *J* = 8.0 Hz, 2H), 7.13 (d, *J* = 8.3 Hz, 2H), 5.56 (s, 1H), 3.68 (d, *J* = 14.3 Hz, 1H), 3.45 (d, *J* = 14.3 Hz, 1H), 1.39 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 179.46, 169.26, 145.18, 141.96, 136.56, 131.75, 131.08, 129.96, 128.50, 128.14, 122.61, 116.10, 62.20, 47.77, 25.97, 24.47, 21.64.

1-acetyl-5-(4-iodophenyl)-3-methyl-3-(tosylmethyl)-1H-pyrrol-2(3H)-one (3e)



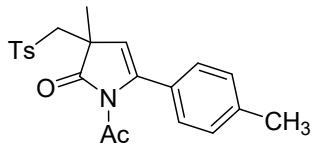
Known compound [1]. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.69 (t, *J* = 7.1 Hz, 4H), 7.29 (d, *J* = 7.9 Hz, 2H), 6.99 (d, *J* = 8.2 Hz, 2H), 5.56 (s, 1H), 3.68 (d, *J* = 14.3 Hz, 1H), 3.44 (d, *J* = 14.3 Hz, 1H), 2.50 (s, 3H), 2.43 (s, 3H), 1.39 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 179.43, 169.24, 145.17, 142.06, 137.01, 136.54, 132.32, 129.95, 128.59, 128.14, 116.10, 94.29, 62.18, 47.78, 25.95, 24.45, 21.63.

Methyl-4-(1-acetyl-4-methyl-5-oxo-4-(tosylmethyl)-4,5-dihydro-1H-pyrrol-2-yl)benzoate (3f)



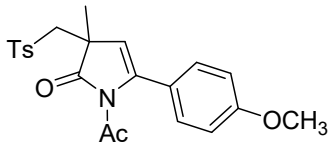
Known compound [1]. ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.03 (d, *J* = 8.3 Hz, 2H), 7.70 (d, *J* = 8.2 Hz, 2H), 7.30 (dd, *J* = 15.7, 8.2 Hz, 4H), 5.62 (s, 1H), 3.93 (s, 3H), 3.70 (d, *J* = 14.3 Hz, 1H), 3.47 (d, *J* = 14.4 Hz, 1H), 2.52 (s, 3H), 2.43 (s, 3H), 1.41 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 179.35, 169.16, 166.62, 145.20, 142.08, 137.20, 136.52, 130.31, 129.96, 129.22, 128.15, 126.78, 116.91, 62.19, 52.21, 47.91, 25.85, 24.45, 21.63.

1-acetyl-3-methyl-5-p-tolyl-3-(tosylmethyl)-1H-pyrrol-2(3H)-one (3g)



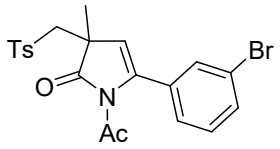
Known compound [1]. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.71 (d, *J* = 8.2 Hz, 2H), 7.27 (d, *J* = 8.1 Hz, 2H), 7.17 (d, *J* = 7.9 Hz, 2H), 7.13 (d, *J* = 8.1 Hz, 2H), 5.49 (s, 1H), 3.69 (d, *J* = 14.4 Hz, 1H), 3.45 (d, *J* = 14.4 Hz, 1H), 2.47 (s, 3H), 2.42 (s, 3H), 2.38 (s, 3H), 1.39 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 179.67, 169.27, 145.02, 142.88, 138.45, 136.58, 129.89, 129.76, 128.61, 128.25, 126.70, 114.95, 62.17, 47.71, 26.07, 24.60, 21.61, 21.35.

1-acetyl-5-(4-methoxyphenyl)-3-methyl-3-(tosylmethyl)-1H-pyrrol-2(3H)-one (3h)



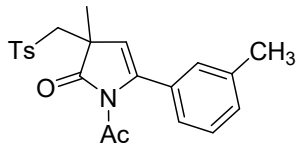
Known compound [1]. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.70 (d, *J* = 8.2 Hz, 2H), 7.17 (d, *J* = 8.7 Hz, 2H), 6.88 (d, *J* = 8.7 Hz, 2H), 5.45 (s, 1H), 3.83 (s, 3H), 3.68 (d, *J* = 14.4 Hz, 1H), 3.45 (d, *J* = 14.4 Hz, 1H), 2.48 (s, 3H), 2.42 (s, 3H), 1.38 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 179.74, 169.40, 159.76, 145.02, 142.62, 136.61, 129.88, 128.24, 128.24, 125.05, 114.46, 113.34, 62.21, 55.31, 47.63, 26.15, 24.63, 21.62.

1-acetyl-5-(3-bromophenyl)-3-methyl-3-(tosylmethyl)-1H-pyrrol-2(3H)-one (3i)



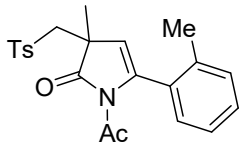
Known compound [1]. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.71 (d, *J* = 8.0 Hz, 2H), 7.48 (d, *J* = 7.8 Hz, 1H), 7.35 (s, 1H), 7.31 (d, *J* = 7.9 Hz, 2H), 7.23 (t, *J* = 7.9 Hz, 1H), 7.16 (d, *J* = 7.6 Hz, 1H), 5.51 (s, 1H), 3.70 (d, *J* = 14.4 Hz, 1H), 3.47 (d, *J* = 14.4 Hz, 1H), 2.52 (s, 3H), 2.45 (s, 3H), 1.39 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 179.33, 169.17, 145.20, 141.52, 136.52, 134.71, 131.45, 129.99, 129.66, 129.33, 128.18, 125.56, 121.91, 116.51, 62.16, 47.79, 25.89, 24.44, 21.66.

1-acetyl-3-methyl-5-m-tolyl-3-(tosylmethyl)-1H-pyrrol-2(3H)-one (3j)



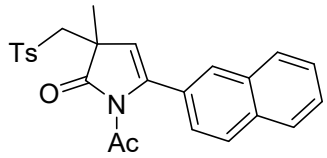
Known compound [1]. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.71 (d, *J* = 8.1 Hz, 2H), 7.28 (d, *J* = 8.0 Hz, 2H), 7.24 (d, *J* = 7.6 Hz, 1H), 7.16 (d, *J* = 7.5 Hz, 1H), 7.05 (s, 1H), 7.02 (d, *J* = 7.6 Hz, 1H), 5.49 (s, 1H), 3.69 (d, *J* = 14.4 Hz, 1H), 3.46 (d, *J* = 14.4 Hz, 1H), 2.49 (s, 3H), 2.42 (s, 3H), 2.37 (s, 3H), 1.39 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 179.65, 169.22, 145.03, 142.99, 137.58, 136.61, 132.59, 129.92, 129.34, 128.26, 127.76, 127.33, 123.91, 115.35, 62.18, 47.77, 26.03, 24.57, 21.63, 21.45.

1-acetyl-3-methyl-5-o-tolyl-3-(tosylmethyl)-1H-pyrrol-2(3H)-one (3k)



Known compound [1]. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.78 (d, *J* = 8.2 Hz, 2H), 7.33 (d, *J* = 8.0 Hz, 2H), 7.29 – 7.23 (m, 2H), 7.19 (dd, *J* = 15.2, 7.5 Hz, 2H), 5.58 (s, 1H), 3.67 (d, *J* = 14.0 Hz, 1H), 3.42 (d, *J* = 14.0 Hz, 1H), 2.48 (s, 3H), 2.43 (s, 3H), 2.26 (s, 3H), 1.41 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 179.57, 168.93, 145.11, 136.91, 133.17, 130.00, 129.59, 128.62, 128.43, 128.01, 125.38, 115.29, 62.17, 47.40, 25.74, 24.94, 21.64, 19.81.

1-acetyl-3-methyl-5-(naphthalen-2-yl)-3-(tosylmethyl)-1,3-dihydro-2H-pyrrol-2-one (3l)

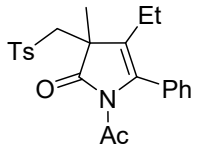


White solid; mp 178.8-180.2 ^{o}C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.86 – 7.82 (m, 2H), 7.80 (d, *J* = 8.5 Hz, 1H), 7.77 – 7.72 (m, 3H), 7.50 (dd, *J* = 5.8, 3.6 Hz, 2H), 7.29 (dd, *J* = 11.5, 4.8 Hz, 3H), 5.62 (s, 1H), 3.73 (d, *J* = 14.4 Hz, 1H), 3.49 (d, *J* = 14.4 Hz, 1H), 2.52 (s, 3H), 2.41 (s, 3H), 1.43 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 179.65, 169.29, 145.07, 142.98, 136.60, 133.17, 132.86, 130.36, 129.95, 128.25, 128.15,

127.75, 127.21, 126.50, 126.42, 125.71, 124.77, 115.89, 62.25, 47.81, 26.01, 24.60, 21.62.

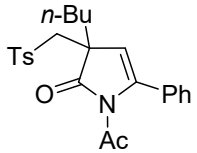
HRMS (ESI, m/z): Calcd. For $C_{25}H_{23}NSO_4Na$ $[M+Na]^+$ 456.1240, found: 456.1243.

1-acetyl-4-ethyl-3-methyl-5-phenyl-3-(tosylmethyl)-1H-pyrrol-2(3H)-one (3m)



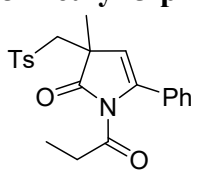
Known compound [1]. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.75 (d, *J* = 8.2 Hz, 2H), 7.39 (t, *J* = 7.1 Hz, 2H), 7.35 (d, *J* = 7.1 Hz, 1H), 7.31 (dd, *J* = 4.8, 3.2 Hz, 3H), 3.70 (d, *J* = 14.3 Hz, 1H), 3.50 (d, *J* = 14.3 Hz, 1H), 2.44 (s, 3H), 2.43 (s, 3H), 2.20 (dd, *J* = 15.2, 7.7 Hz, 1H), 1.94 (dd, *J* = 15.0, 7.5 Hz, 1H), 1.38 (s, 3H), 0.90 (t, *J* = 7.7 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 179.44, 169.10, 145.03, 137.67, 136.89, 132.57, 129.93, 128.33, 128.14, 128.01, 127.94, 126.12, 61.76, 50.47, 26.19, 24.64, 21.64, 18.05, 14.59.

1-acetyl-3-butyl-5-phenyl-3-(tosylmethyl)-1H-pyrrol-2(3H)-one (3n)



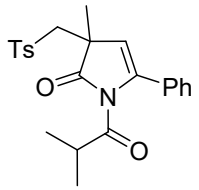
Known compound [1]. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.70 (d, *J* = 8.1 Hz, 2H), 7.42 – 7.30 (m, 4H), 7.26 (t, *J* = 3.7 Hz, 5H), 5.42 (s, 1H), 3.69 (d, *J* = 14.4 Hz, 1H), 3.49 (d, *J* = 14.4 Hz, 1H), 2.49 (s, 3H), 2.41 (s, 3H), 1.75 – 1.63 (m, 2H), 1.27 (d, *J* = 4.5 Hz, 3H), 1.14 – 1.07 (m, 1H), 0.85 (t, *J* = 7.0 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 179.39, 169.08, 145.00, 143.78, 136.69, 132.82, 129.88, 128.48, 128.22, 127.90, 126.82, 113.99, 61.79, 51.71, 38.07, 26.05, 25.65, 22.61, 21.61, 13.76.

3-methyl-5-phenyl-1-propionyl-3-(tosylmethyl)-1H-pyrrol-2(3H)-one (3o)



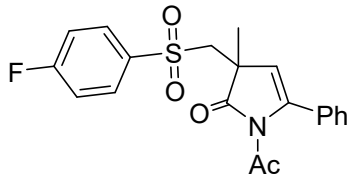
Known compound [1]. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.70 (d, *J* = 8.1 Hz, 2H), 7.37 – 7.35 (m, 3H), 7.27 (s, 1H), 7.26 – 7.25 (m, 1H), 7.25 – 7.21 (m, 2H), 5.51 (s, 1H), 3.69 (d, *J* = 14.4 Hz, 1H), 3.45 (d, *J* = 14.4 Hz, 1H), 2.94 – 2.84 (m, 2H), 2.41 (s, 3H), 1.39 (s, 3H), 1.14 (t, *J* = 7.3 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 179.42, 173.23, 145.03, 143.01, 136.61, 132.86, 129.87, 128.47, 128.22, 127.93, 126.71, 124.16, 115.49, 62.16, 47.83, 31.58, 24.63, 21.62, 8.33.

1-isobutyryl-3-methyl-5-phenyl-3-(tosylmethyl)-1H-pyrrol-2(3H)-one (3p)



Known compound [1]. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.69 (d, *J* = 8.1 Hz, 2H), 7.37 – 7.33 (m, 3H), 7.24 (d, *J* = 8.0 Hz, 2H), 7.21 – 7.17 (m, 2H), 5.50 (s, 1H), 3.70 (d, *J* = 14.5 Hz, 1H), 3.68 – 3.62 (m, 1H), 3.46 (d, *J* = 14.4 Hz, 1H), 2.40 (s, 3H), 1.40 (s, 3H), 1.24 (d, *J* = 6.9 Hz, 3H), 1.18 (d, *J* = 6.8 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 178.90, 176.66, 144.96, 143.16, 136.69, 132.81, 129.86, 128.49, 128.18, 128.05, 126.22, 115.30, 62.11, 48.11, 35.57, 24.69, 21.63, 18.60, 18.37.

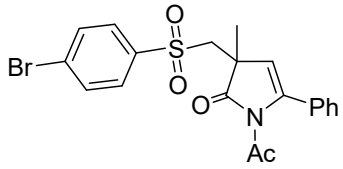
1-acetyl-3-(((4-fluorophenyl)sulfonyl)methyl)-3-methyl-5-phenyl-1,3-dihydro-2H-pyrrol-2-one (4a)



White solid; mp 154.0-155.6 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.84 (dd, *J* = 8.6, 5.0 Hz, 2H), 7.41 – 7.34 (m, 3H), 7.25 (dd, *J* = 8.0, 4.5 Hz, 2H), 7.15 (t, *J* = 8.4 Hz, 2H), 5.50 (s, 1H), 3.71 (d, *J* = 14.4 Hz, 1H), 3.48 (d, *J* = 14.4 Hz, 1H), 2.53 (s, 3H), 1.40 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 179.54, 169.31, 165.93 (*J* = 255 Hz), 143.19, 135.69, 135.67, 132.56, 131.17, 131.10, 128.64, 128.00, 126.71, 116.71, 116.56, 115.23, 62.35, 47.82, 26.05, 24.51. ^{19}F NMR (565 MHz, $CDCl_3$) δ -102.69.

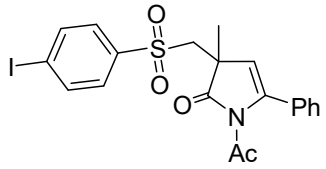
HRMS (ESI, m/z): Calcd. For $C_{20}H_{18}NO_4SFNa$ $[M+Na]^+$ 410.0833, found: 410.0836.

1-acetyl-3-((4-bromophenylsulfonyl)methyl)-3-methyl-5-phenyl-1H-pyrrol-2(3H)-one (4b)



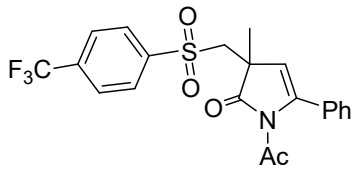
Known compound [1]. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.68 (d, *J* = 8.6 Hz, 2H), 7.62 (d, *J* = 8.6 Hz, 2H), 7.44 – 7.33 (m, 3H), 7.28 – 7.18 (m, 3H), 5.49 (s, 1H), 3.70 (d, *J* = 14.4 Hz, 1H), 3.47 (d, *J* = 14.4 Hz, 1H), 2.52 (s, 3H), 1.40 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 179.43, 169.26, 143.21, 138.48, 132.64, 132.48, 129.73, 129.42, 128.65, 127.99, 126.69, 115.14, 62.19, 47.75, 26.01, 24.56.

1-acetyl-3-((4-iodophenylsulfonyl)methyl)-3-methyl-5-phenyl-1H-pyrrol-2(3H)-one (4c)



Known compound [1]. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.84 (d, *J* = 8.2 Hz, 2H), 7.52 (d, *J* = 8.2 Hz, 2H), 7.39 – 7.34 (m, 3H), 7.24 – 7.19 (m, 2H), 5.48 (s, 1H), 3.70 (d, *J* = 14.4 Hz, 1H), 3.46 (d, *J* = 14.4 Hz, 1H), 2.52 (s, 3H), 1.40 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 179.43, 169.27, 143.18, 139.11, 138.64, 132.49, 129.51, 128.66, 128.00, 126.71, 115.18, 102.06, 62.13, 47.75, 26.04, 24.59.

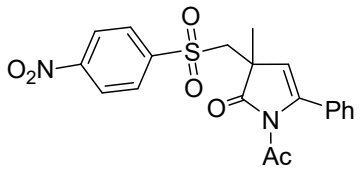
1-acetyl-3-methyl-5-phenyl-3-((4-(trifluoromethyl)phenylsulfonyl)methyl)-1H-pyrrol-2(3H)-one (4d)



Known compound [1]. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.96 (d, *J* = 8.2 Hz, 2H), 7.75 (d, *J* = 8.3 Hz, 2H), 7.43 – 7.33 (m, 3H), 7.21 (dd, *J* = 6.4, 2.7 Hz, 2H), 5.46 (s, 1H), 3.74 (d, *J* = 14.4 Hz, 1H), 3.52 (d, *J* = 14.4 Hz, 1H), 2.52 (s, 3H), 1.41 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 179.34, 169.26, 143.38, 135.65 (*J* = 33 Hz), 132.38, 128.84,

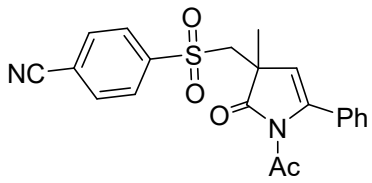
128.73, 128.02, 126.64, 126.48 (J = 4.5 Hz), 122.99 (J = 122.3 Hz), 114.96, 62.11, 47.73, 26.00, 24.52. ^{19}F NMR (565 MHz, $CDCl_3$) δ -63.28.

1-acetyl-3-methyl-3-((4-nitrophenylsulfonyl)methyl)-5-phenyl-1H-pyrrol-2(3H)-one (4j)



Known compound [1]. ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.30 (d, J = 8.7 Hz, 2H), 8.03 (d, J = 8.7 Hz, 2H), 7.40 – 7.35 (m, 3H), 7.23 (dd, J = 6.3, 2.8 Hz, 2H), 5.45 (s, 1H), 3.75 (d, J = 14.4 Hz, 1H), 3.54 (d, J = 14.4 Hz, 1H), 2.56 (s, 3H), 1.43 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 179.33, 169.30, 150.92, 145.13, 143.70, 132.33, 129.66, 128.84, 128.10, 126.63, 124.49, 114.71, 62.22, 47.79, 26.07, 24.42.

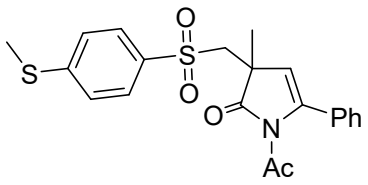
4-(((1-acetyl-3-methyl-2-oxo-5-phenyl-2,3-dihydro-1H-pyrrol-3-yl)methyl)sulfonyl)benzonitrile (4f)



White solid; mp 189.4-191.5 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.95 (d, J = 8.5 Hz, 2H), 7.77 (d, J = 8.5 Hz, 2H), 7.41 – 7.36 (m, 3H), 7.25 – 7.20 (m, 2H), 5.44 (s, 1H), 3.73 (d, J = 14.4 Hz, 1H), 3.51 (d, J = 14.4 Hz, 1H), 2.56 (s, 3H), 1.42 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 179.33, 169.29, 143.66, 143.62, 133.05, 132.35, 128.90, 128.82, 128.09, 126.64, 117.77, 116.91, 114.76, 62.15, 47.77, 26.07, 24.43.

HRMS (ESI, m/z): Calcd. For $C_{21}H_{18}N_2O_4SNa$ $[M+Na]^+$ 417.0879, found: 417.0883.

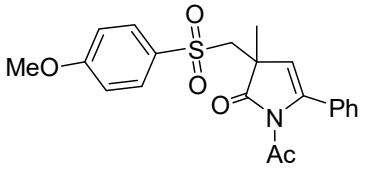
1-acetyl-3-methyl-3-(((4-(methylthio)phenyl)sulfonyl)methyl)-5-phenyl-1,3-dihydro-2H-pyrrol-2-one (4g)



White solid; mp 102.9-104.8 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.68 (d, *J* = 8.5 Hz, 2H), 7.38 – 7.34 (m, 3H), 7.23 (t, *J* = 7.2 Hz, 4H), 5.49 (s, 1H), 3.71 (d, *J* = 14.4 Hz, 1H), 3.46 (d, *J* = 14.4 Hz, 1H), 2.49 (s, 3H), 2.49 (s, 3H), 1.39 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 179.50, 169.31, 147.81, 142.88, 134.77, 132.65, 128.54, 128.49, 127.93, 126.75, 125.29, 115.56, 62.24, 47.78, 26.01, 24.69, 14.65.

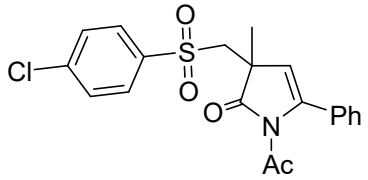
HRMS (ESI, m/z): Calcd. For $C_{21}H_{21}N_2O_4S_2Na$ $[M+Na]^+$ 438.0804, found: 438.0807.

1-acetyl-3-((4-methoxyphenylsulfonyl)methyl)-3-methyl-5-phenyl-1H-pyrrol-2(3H)-one (4h)



Known compound [1]. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.74 (d, *J* = 8.8 Hz, 2H), 7.41 – 7.33 (m, 3H), 7.25 (d, *J* = 3.7 Hz, 2H), 6.91 (d, *J* = 8.8 Hz, 2H), 5.50 (s, 1H), 5.12 – 5.10 (m, 1H), 3.70 (d, *J* = 14.4 Hz, 1H), 3.45 (d, *J* = 14.4 Hz, 1H), 2.50 (s, 3H), 1.39 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 179.59, 169.29, 163.90, 142.79, 132.71, 130.90, 130.46, 128.49, 127.90, 126.77, 115.66, 114.45, 62.36, 55.73, 47.80, 26.04, 24.65.

1-acetyl-3-(((4-chlorophenyl)sulfonyl)methyl)-3-methyl-5-phenyl-1,3-dihydro-2H-pyrrol-2-one (4i)

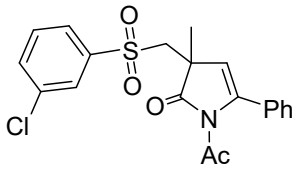


White solid; mp 140.5-142.1 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.76 (d, *J* = 8.5 Hz, 2H), 7.45 (d, *J* = 8.5 Hz, 2H), 7.41 – 7.32 (m, 3H), 7.23 (dd, *J* = 6.5, 2.8 Hz, 2H), 5.50 (s, 1H), 3.71 (d, *J* = 14.4 Hz, 1H), 3.47 (d, *J* = 14.4 Hz, 1H), 2.53 (s, 3H), 1.41 (s, 3H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 179.47, 169.29, 143.23, 140.85, 137.99, 132.51, 129.70, 129.66, 128.67, 128.00, 126.71, 115.17, 62.25, 47.79, 26.02, 24.55.

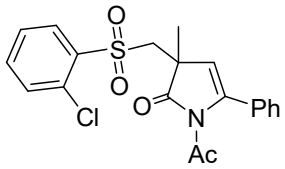
HRMS (ESI, m/z): Calcd. For $C_{20}H_{18}NClSO_4Na$ $[M+Na]^+$ 426.0537, found: 426.0540.

1-acetyl-3-((3-chlorophenylsulfonyl)methyl)-3-methyl-5-phenyl-1H-pyrrol-2(3H)-one (4j)



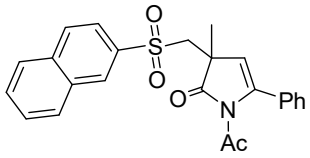
Known compound [1]. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.83 (s, 1H), 7.72 (d, *J* = 7.8 Hz, 1H), 7.60 (d, *J* = 8.0 Hz, 1H), 7.44 (d, *J* = 7.9 Hz, 1H), 7.38 – 7.35 (m, 3H), 7.26 – 7.24 (m, 2H), 5.49 (s, 1H), 3.71 (d, *J* = 14.4 Hz, 1H), 3.50 (d, *J* = 14.4 Hz, 1H), 2.55 (s, 3H), 1.42 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 179.48, 169.27, 143.41, 141.38, 135.60, 134.15, 132.49, 130.64, 128.63, 128.16, 127.99, 126.75, 126.29, 114.94, 62.17, 47.78, 26.08, 24.47.

1-acetyl-3-((2-chlorophenylsulfonyl)methyl)-3-methyl-5-phenyl-1H-pyrrol-2(3H)-one (4k)



Known compound [1]. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.93 (d, *J* = 7.9 Hz, 1H), 7.54 (t, *J* = 9.4 Hz, 2H), 7.33 (d, *J* = 4.1 Hz, 2H), 7.27 (d, *J* = 7.6 Hz, 2H), 7.14 (d, *J* = 4.3 Hz, 2H), 5.32 (s, 1H), 3.93 (s, 2H), 2.54 (s, 3H), 1.42 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 179.41, 169.36, 143.29, 137.12, 134.94, 132.69, 132.53, 131.88, 128.56, 127.89, 127.48, 126.57, 115.08, 60.13, 47.71, 26.06, 24.40.

1-acetyl-3-methyl-3-((naphthalen-2-ylsulfonyl)methyl)-5-phenyl-1H-pyrrol-2(3H)-one(4l)



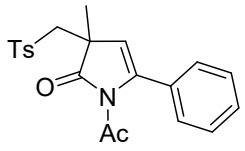
Known compound [1]. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.35 (s, 1H), 7.95 (d, *J* = 8.6 Hz, 1H), 7.91 (d, *J* = 8.2 Hz, 1H), 7.84 – 7.74 (m, 2H), 7.67 (t, *J* = 7.5 Hz, 1H), 7.58 (t, *J* = 7.5 Hz, 1H), 7.37 – 7.29 (m, 3H), 7.19 (d, *J* = 7.3 Hz, 2H), 5.44 (s, 1H), 3.82 (d, *J* = 14.5 Hz, 1H), 3.57 (d, *J* = 14.5 Hz, 1H), 2.43 (s, 3H), 1.40 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 179.55, 169.29, 143.10, 136.20, 135.30, 132.59, 131.91, 130.28, 129.65, 129.53, 128.52, 127.92, 127.89, 127.75, 126.70, 122.56, 115.27, 62.08, 47.84, 25.93, 24.58.

Reference:

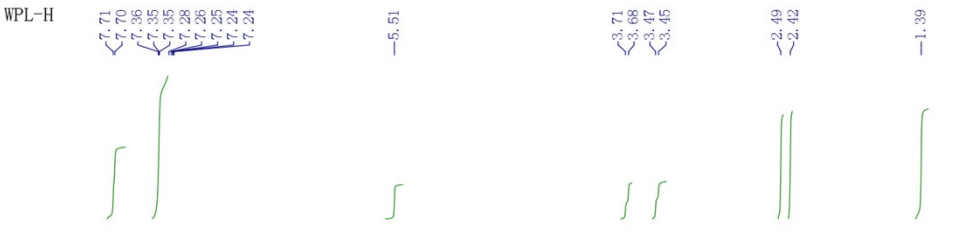
(1) R. Ding, Y.-L. Liu, H. Hao, C.-Y. Chen, L. Liu, N.-S. Chen, Y. Guo, P.-L. Wang, *Org. Chem. Front*., **2021**, *8*, 3123.

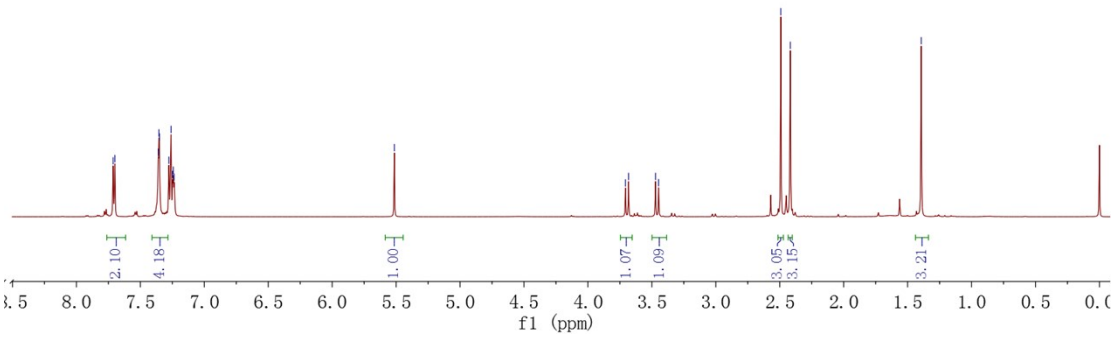
(2) (a) B. Panda, T. K. Sarkar, *Chem. Commun*. **2010**, *46*, 3131. (b) R. Cai, M. Lu, E. Y. Aguilera, Y. M. Xi, N. G. Akhmedov, J. L. Petersen, H. Chen, X. D. Shi, *Angew. Chem. Int. Ed*. **2015**, *54*, 8772. (c) H. Wang, S. Sun, J. Cheng. *Org. Lett,* **2017**, *19*, 5844.

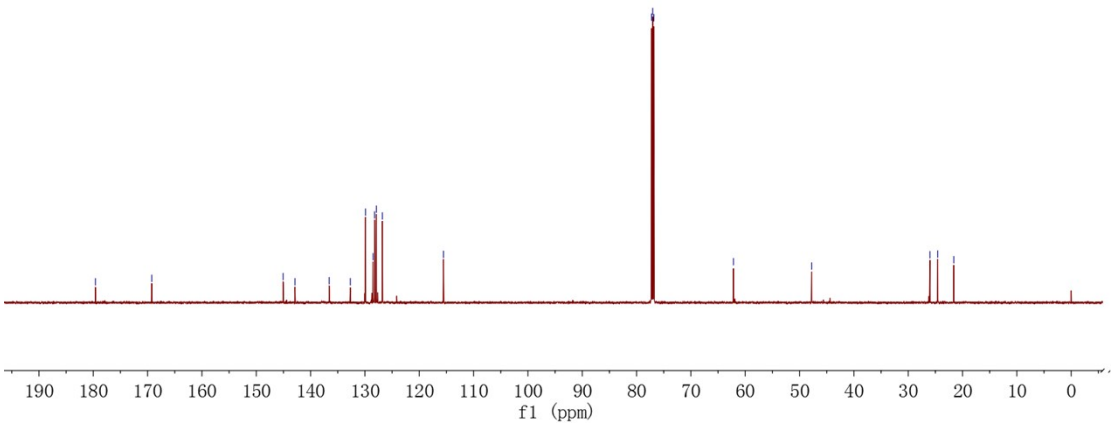
NMR spectra

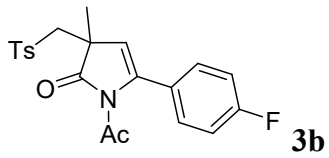


3a

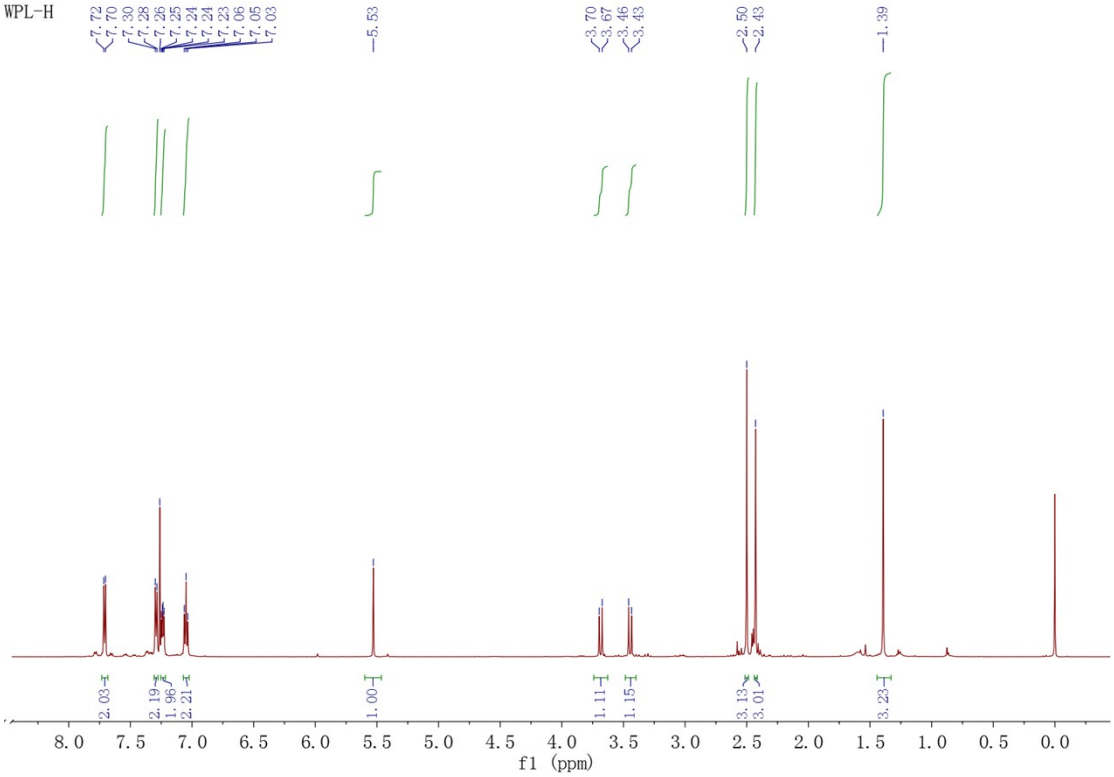







Ts
O
N
Ac
F

3b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7.70
7.30
7.28
7.26
7.25
7.24
7.24
7.23
7.06
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7.03
5.53
3.70
3.67
3.46
3.43
2.50
2.43
1.39
2.03
2.19
1.96
2.21
1.00
1.11
1.15
3.13
3.01
3.23
8.0
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7.0
6.5
6.0
5.5
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4.5
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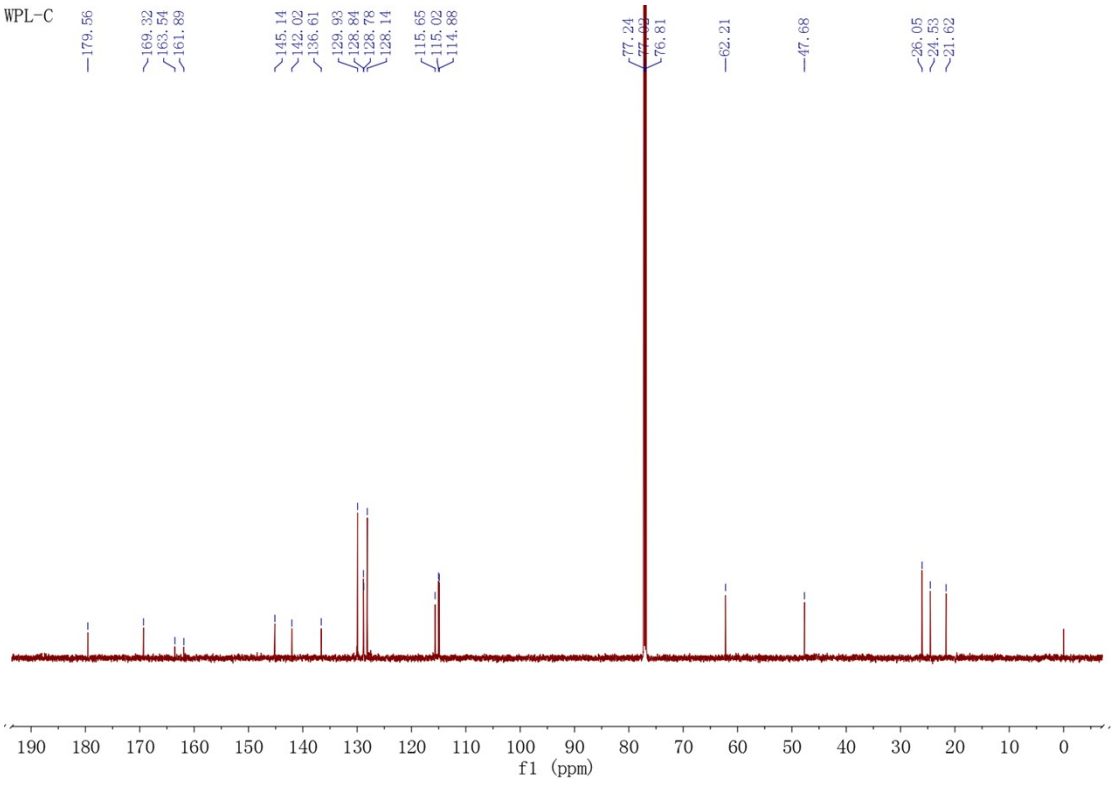
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


WPL-C
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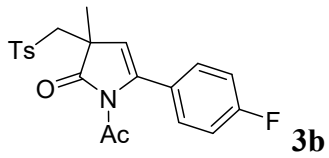
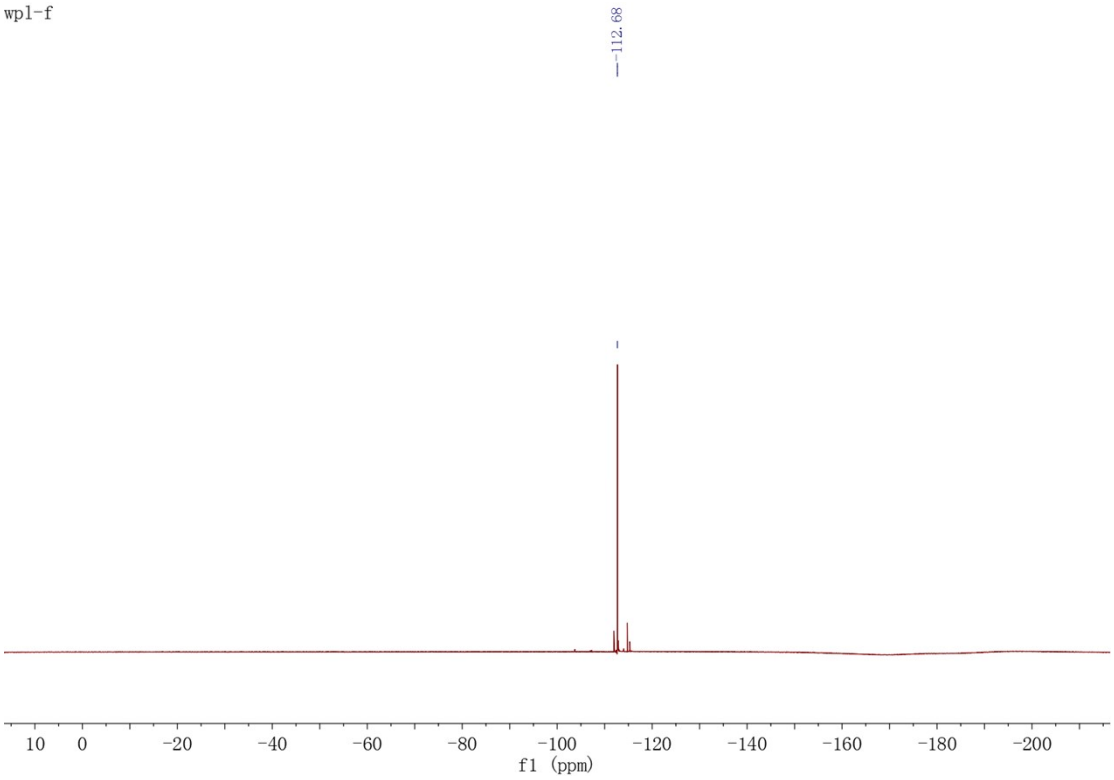
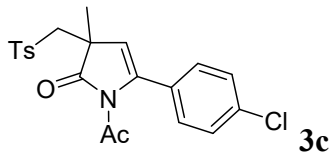
169.32
163.54
161.89
145.14
142.02
136.61
129.93
128.84
128.78
128.14
115.65
115.02
114.88
77.24
77.02
76.81
62.21
47.68
26.05
24.53
21.62
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


Ts
O
N
Ac
F

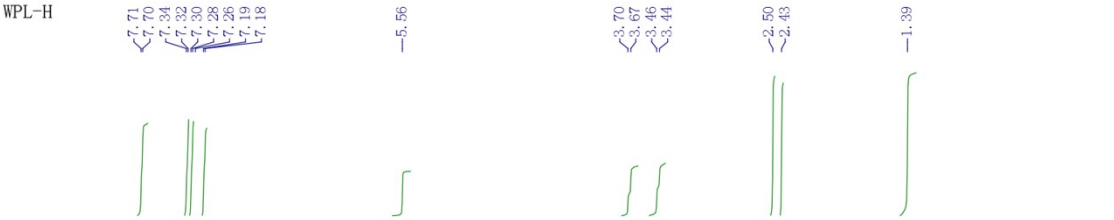
3b

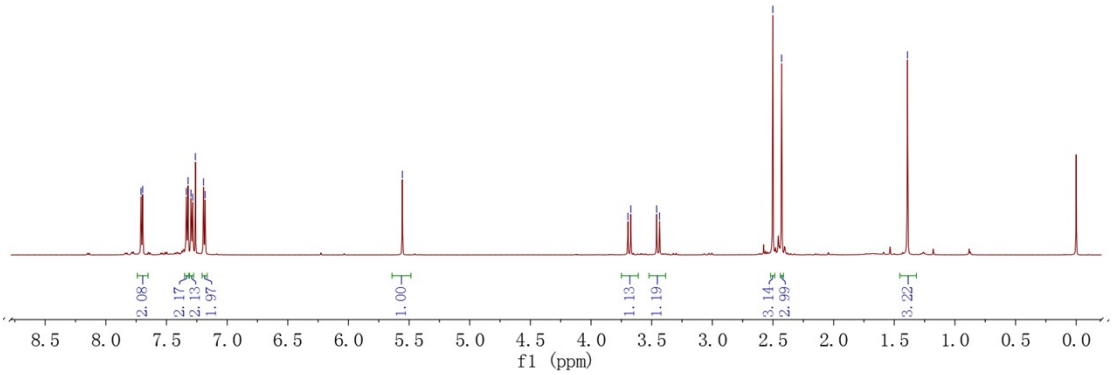

wpl-f
-112.68
10
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
f1 (ppm)


Ts
O
N
Ac
Cl

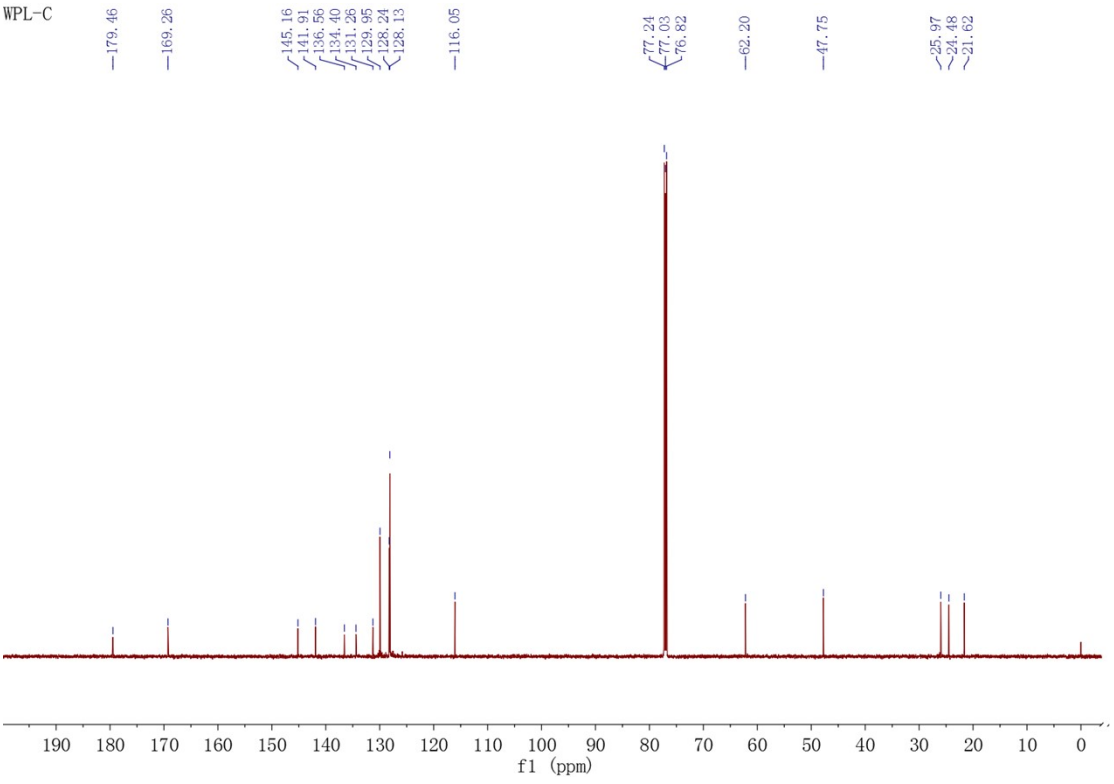
3c

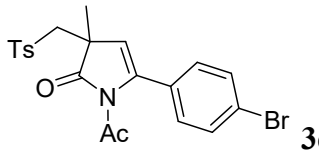
WPL-H


7.71
7.70
7.34
7.32
7.30
7.28
7.26
7.19
7.18
5.56
3.70
3.67
3.46
3.44
2.50
2.43
1.39

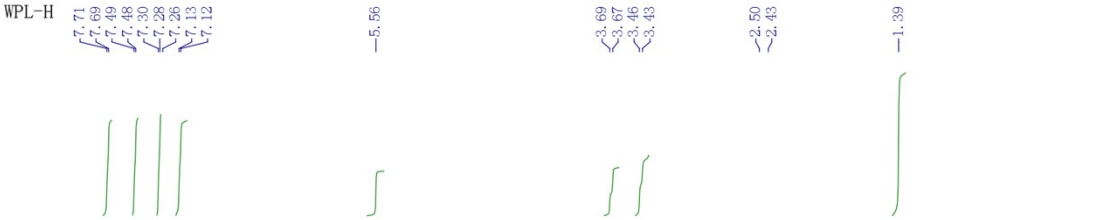

2.08
2.17
2.13
1.97
1.00
1.13
1.19
3.14
2.99
3.22
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

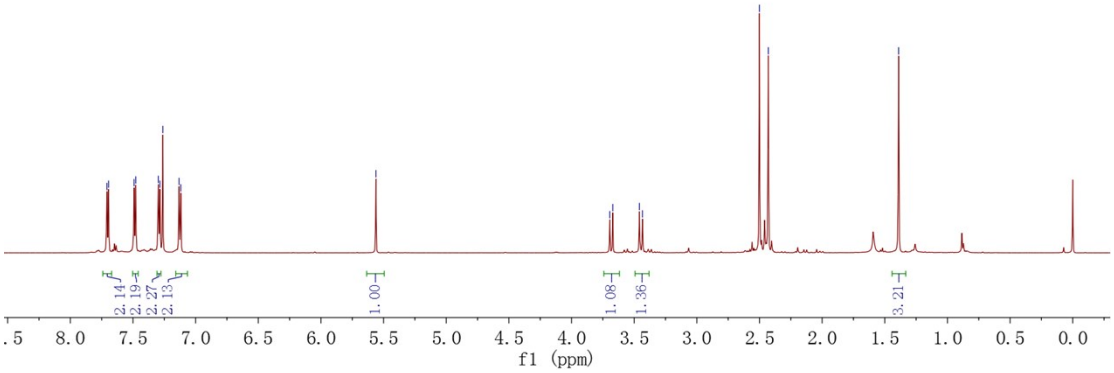
WPL-C

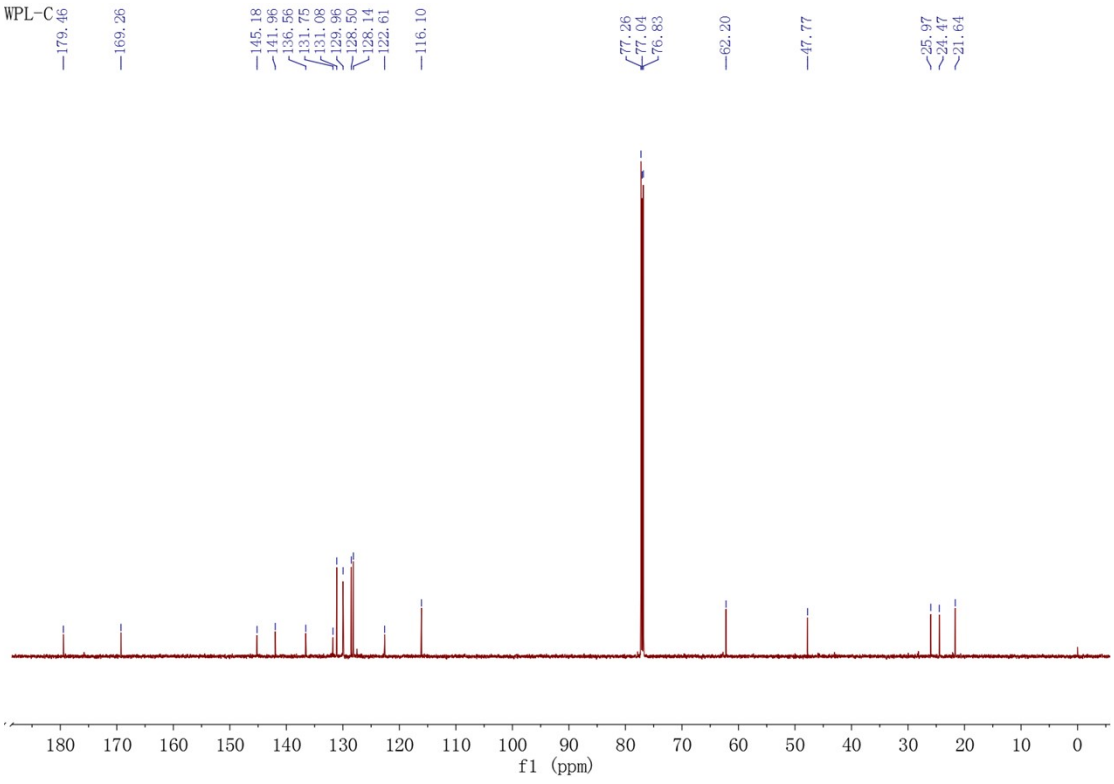

179.46
169.26
145.16
141.91
136.56
134.40
131.26
129.95
128.24
128.13
116.05
77.24
77.03
76.82
62.20
47.75
25.97
24.48
21.62
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

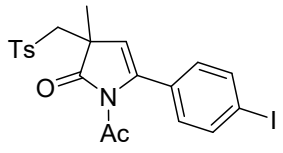

Ts
O
N
Ac
Br

3d

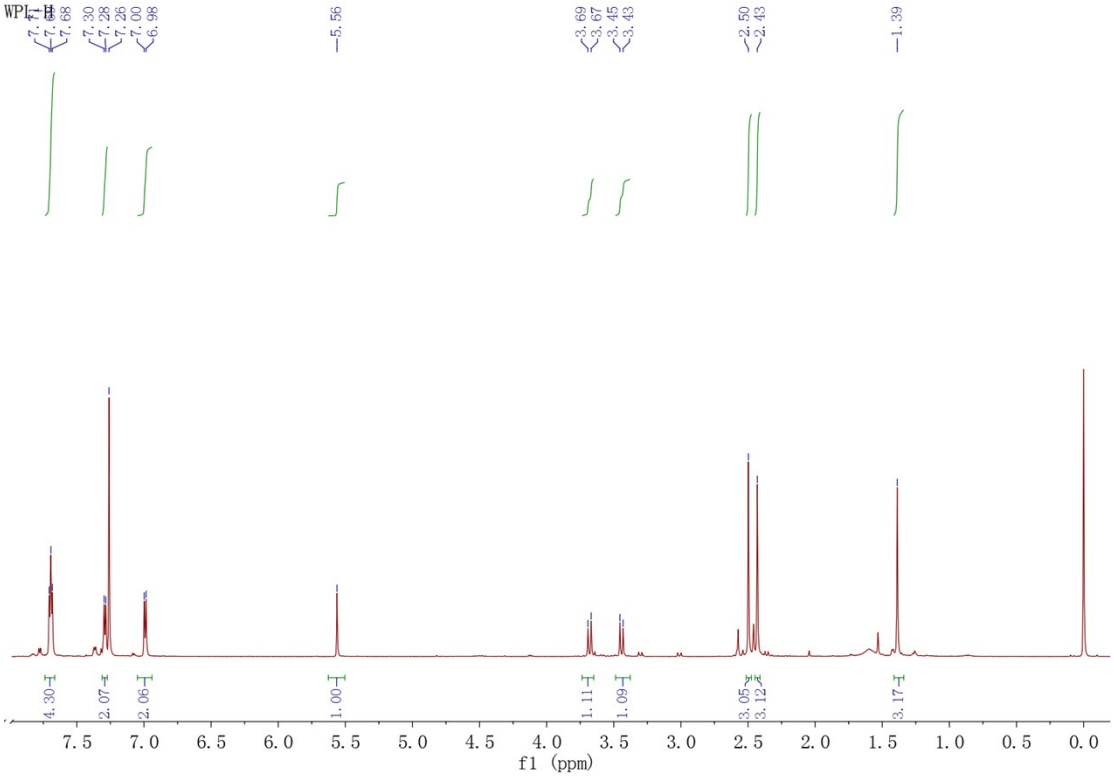

WPL-H
7.71
7.69
7.49
7.48
7.30
7.28
7.26
7.13
7.12
5.56
3.69
3.67
3.46
3.43
2.50
2.43
1.39

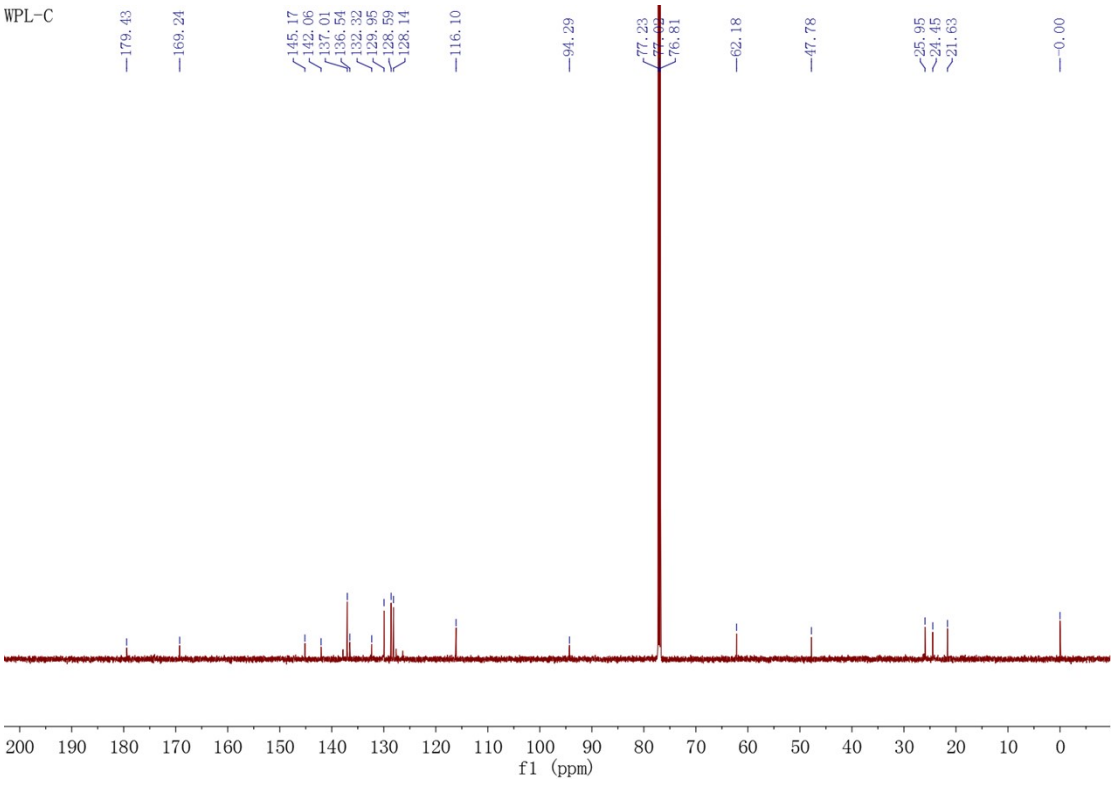

2.14
2.19
2.27
2.13
1.00
1.08
1.36
3.21
f1 (ppm)

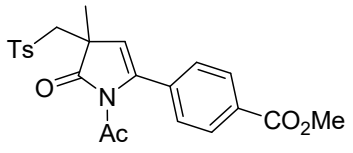

WPL-C
179.46
169.26
145.18
141.96
136.56
131.75
131.08
129.96
128.50
128.14
122.61
116.10
77.26
77.04
76.83
62.20
47.77
25.97
24.47
21.64
f1 (ppm)


Ts
O
N
Ac
I

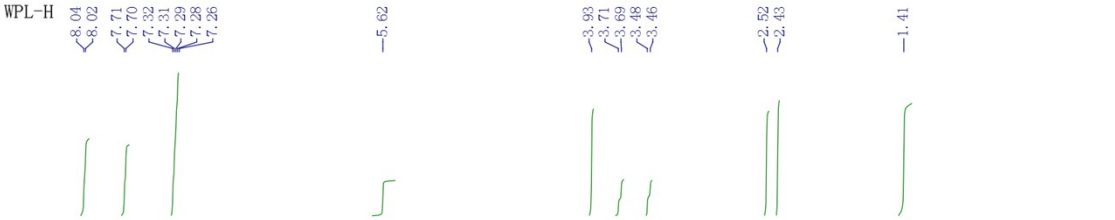
3e

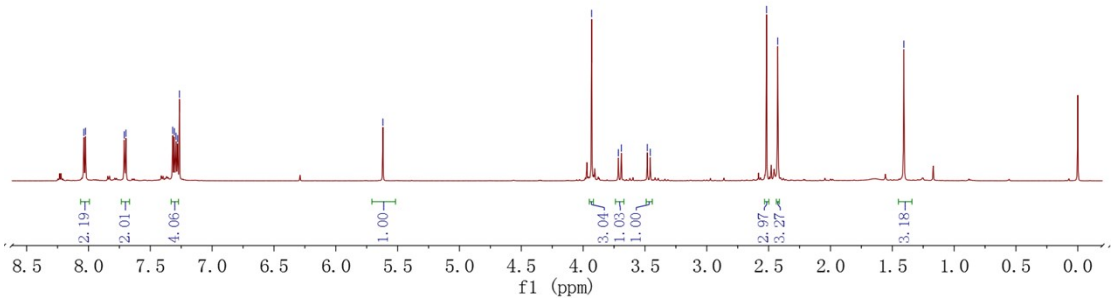

WPL-H
7.71
7.68
7.30
7.28
7.26
7.00
6.98
5.56
3.69
3.67
3.45
3.43
2.50
2.43
1.39
4.30
2.07
2.06
1.00
1.11
1.09
3.05
3.12
3.17
7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

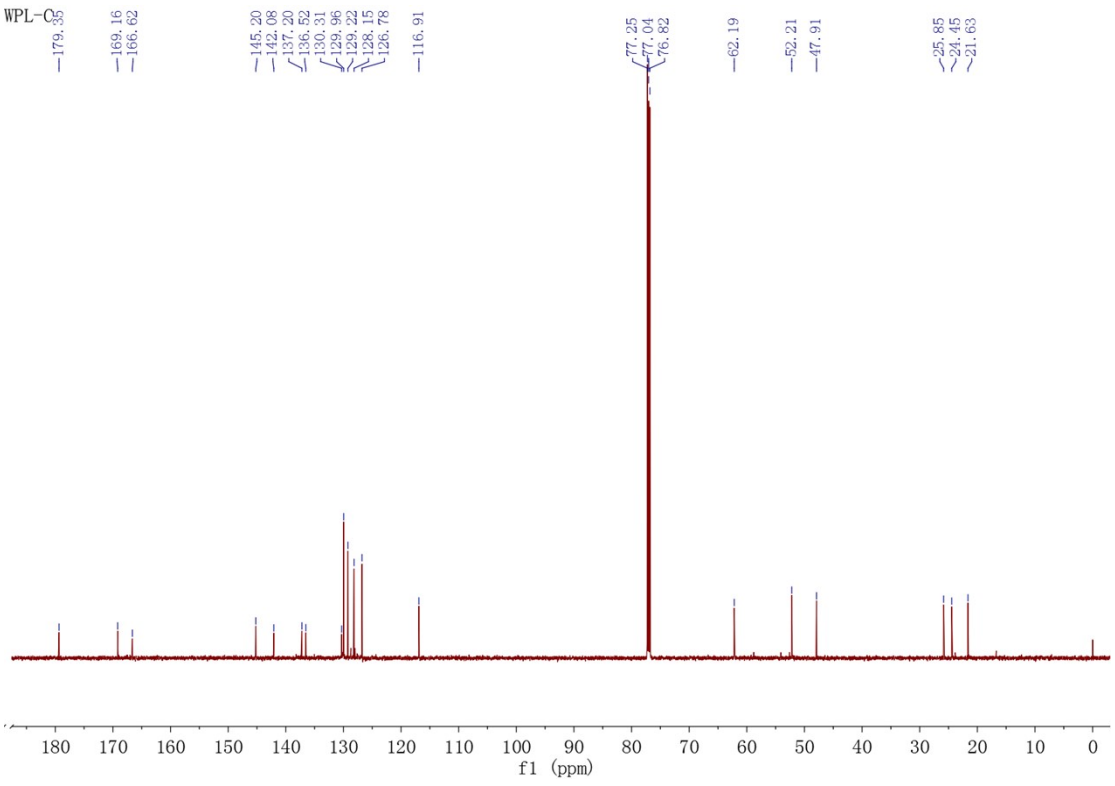

WPL-C
179.43
169.24
145.17
142.06
137.01
136.54
132.32
129.95
128.59
128.14
116.10
94.29
77.23
77.02
76.81
62.18
47.78
25.95
24.45
21.63
-0.00
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

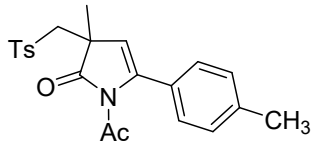

Ts
O
N
Ac
CO2Me

3f

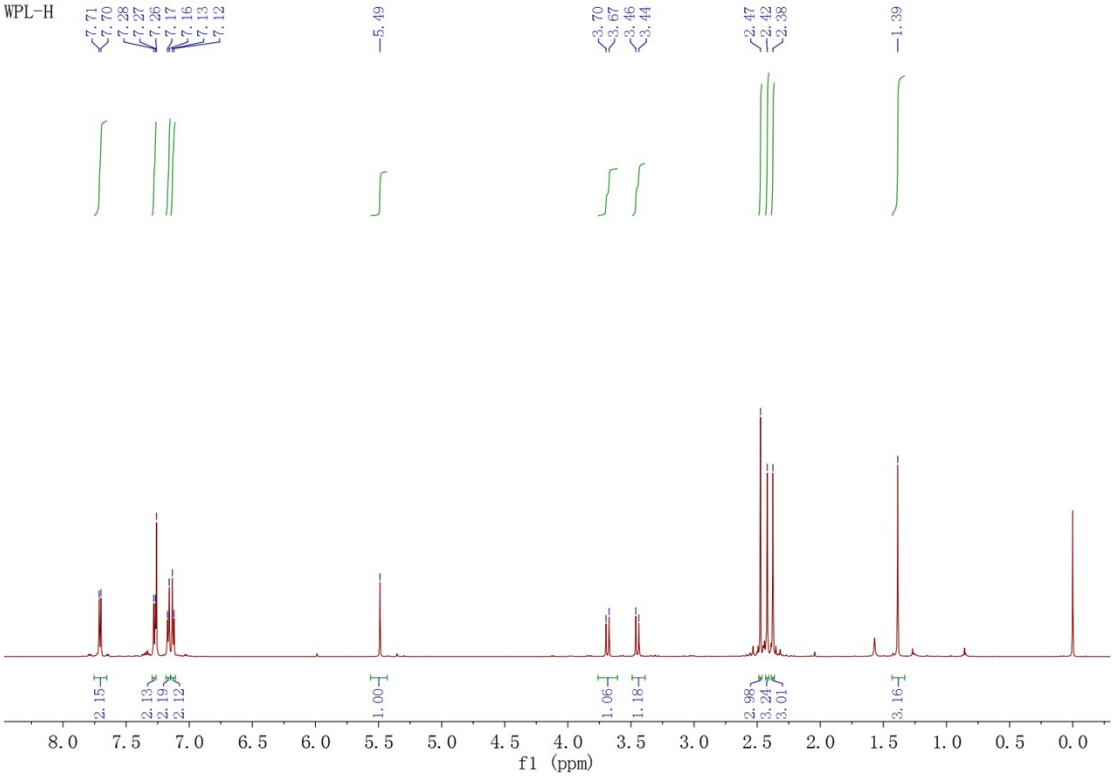

WPL-H
8.04
8.02
7.71
7.70
7.32
7.31
7.29
7.28
7.26
5.62
3.93
3.71
3.69
3.48
3.46
2.52
2.43
1.41

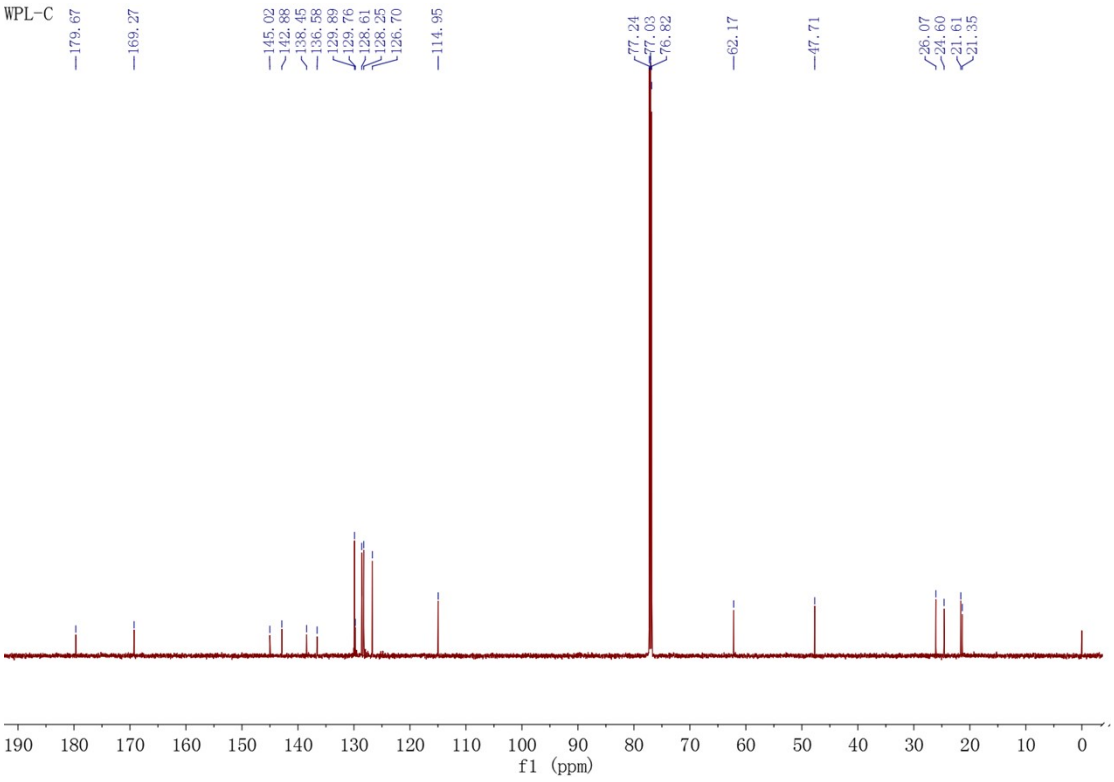

2.19
2.01
4.06
1.00
3.04
1.03
1.00
2.97
3.27
3.18
f1 (ppm)

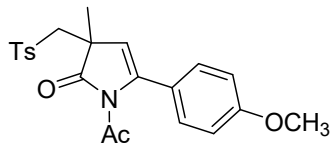

WPL-C
179.55
169.16
166.62
145.20
142.08
137.20
136.52
130.31
129.96
129.22
128.15
126.78
116.91
77.25
77.04
76.82
62.19
52.21
47.91
25.85
24.45
21.63
f1 (ppm)


Ts
O
N
Ac
CH3

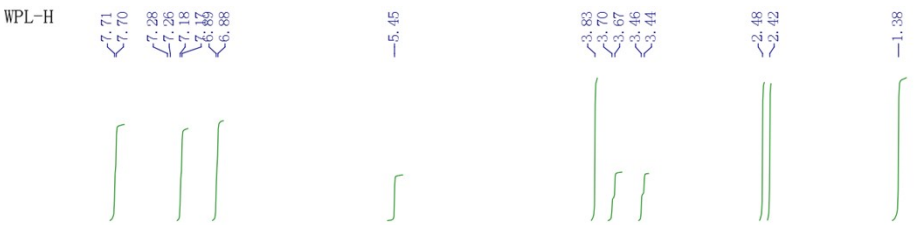
3g

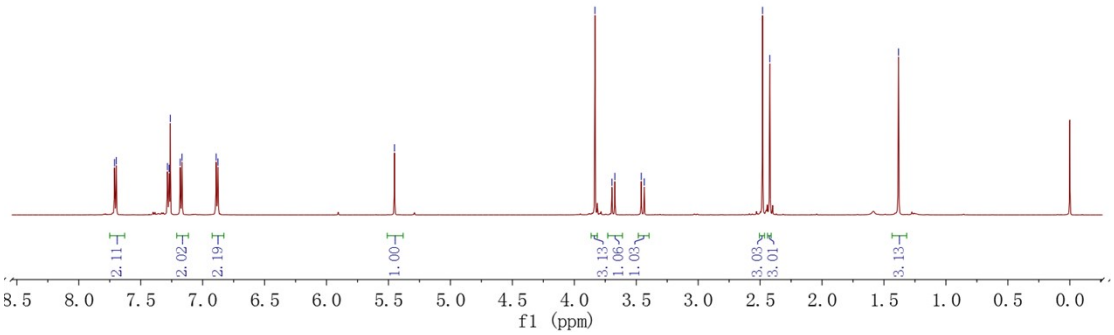

WPL-H
7.71
7.70
7.28
7.27
7.26
7.17
7.16
7.13
7.12
5.49
3.70
3.67
3.46
3.44
2.47
2.42
2.38
1.39
2.15
2.13
2.19
2.12
1.00
1.06
1.18
2.98
3.24
3.01
3.16
f1 (ppm)


WPL-C
179.67
169.27
145.02
142.88
138.45
136.58
129.89
129.76
128.61
128.25
126.70
114.95
77.24
77.03
76.82
62.17
47.71
26.07
24.60
21.61
21.35
f1 (ppm)

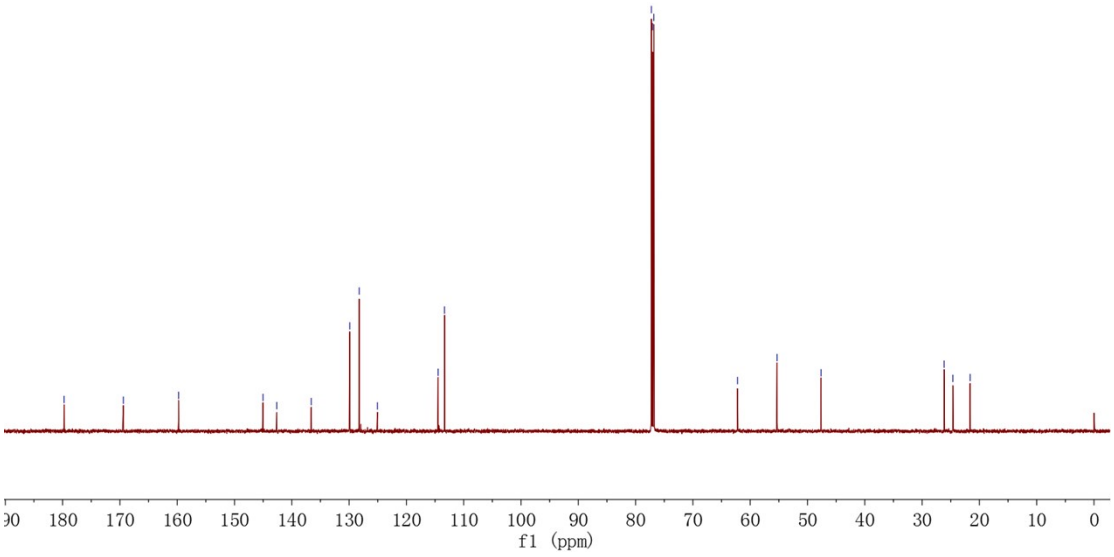

Ts
O
N
Ac
OCH3

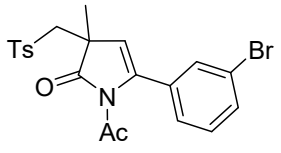
3h


WPL-H
7.71
7.70
7.28
7.26
7.18
6.88
5.45
3.83
3.70
3.67
3.46
3.44
2.48
2.42
1.38

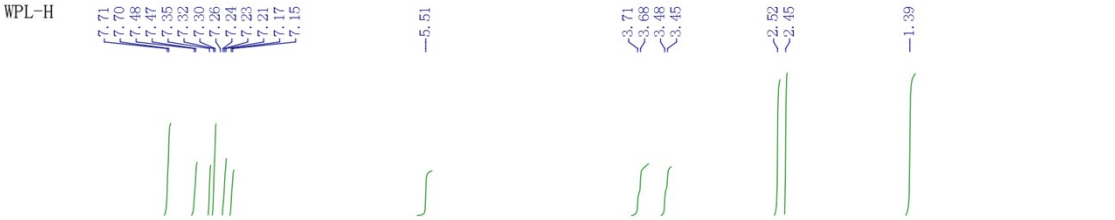

2.11
2.02
2.19
1.00
3.13
1.06
1.03
3.03
3.01
3.13
f1 (ppm)

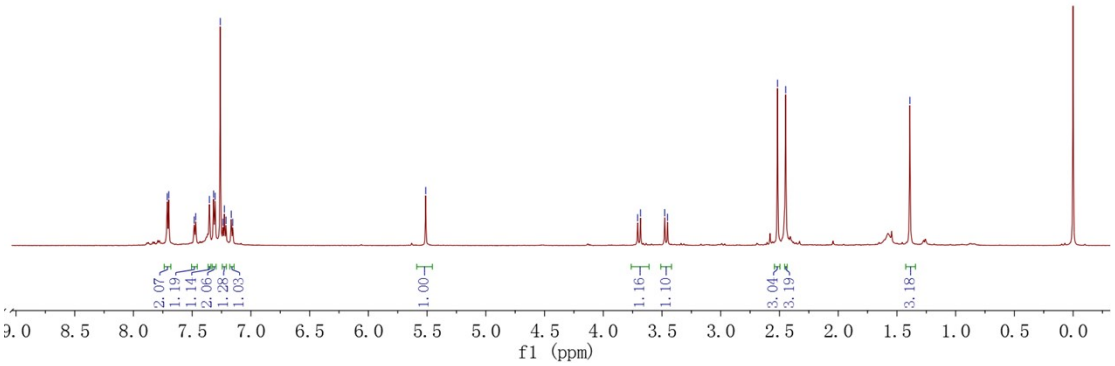

WPL-C
179.74
169.40
159.76
145.02
142.62
136.61
129.88
128.24
125.05
114.46
113.34
77.24
77.03
76.82
62.21
55.31
47.63
26.15
24.63
21.62

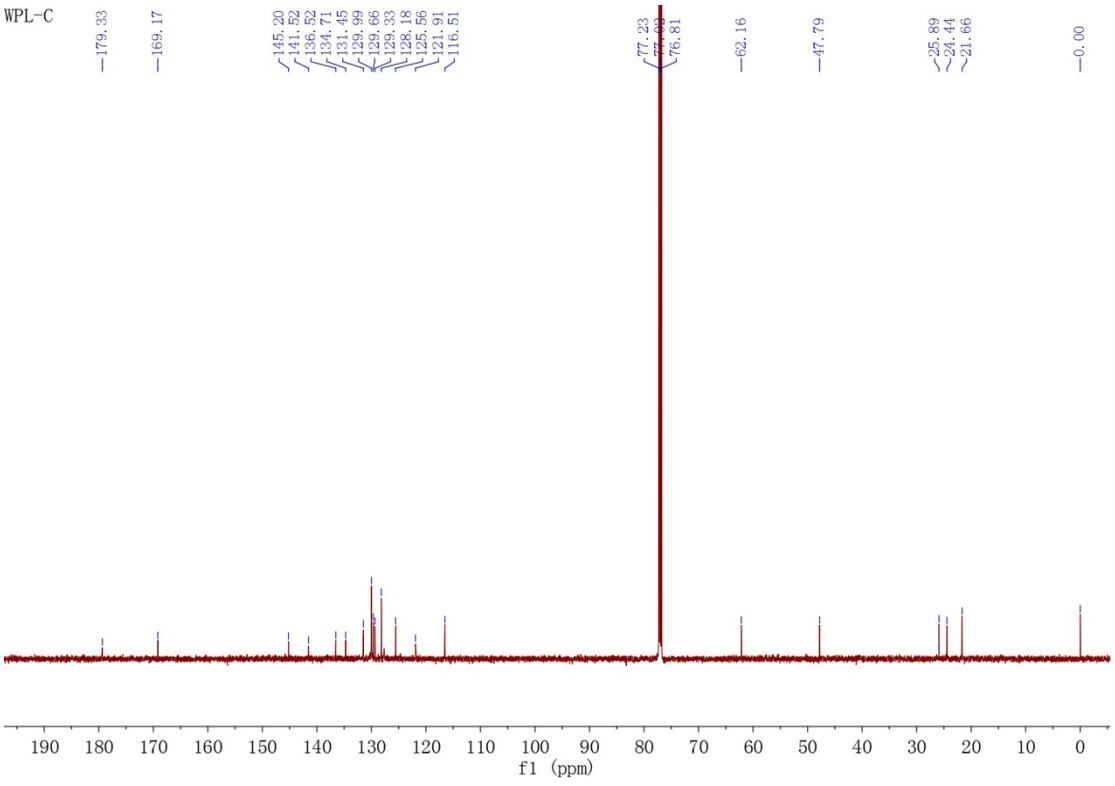

f1 (ppm)

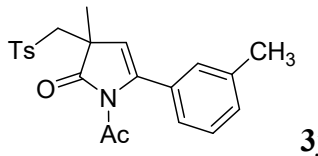

Ts
O
N
Ac
Br

3i

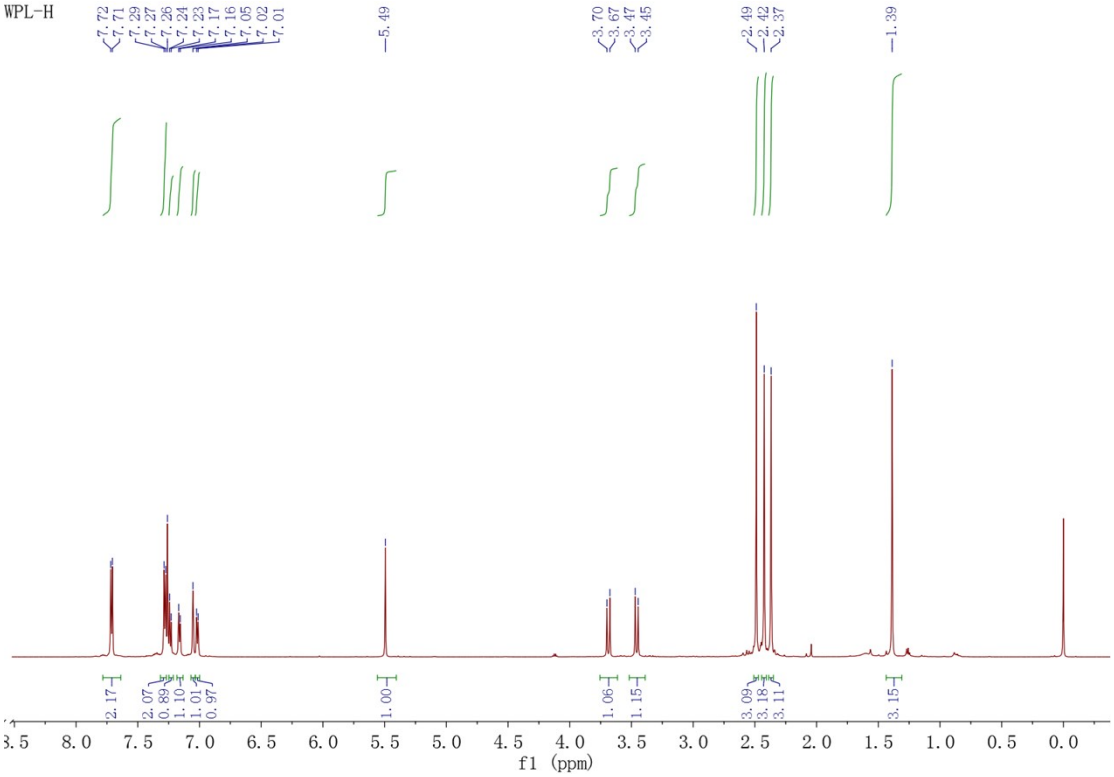

WPL-H
7.71
7.70
7.48
7.47
7.35
7.32
7.30
7.26
7.24
7.23
7.21
7.17
7.15
5.51
3.71
3.68
3.48
3.45
2.52
2.45
1.39

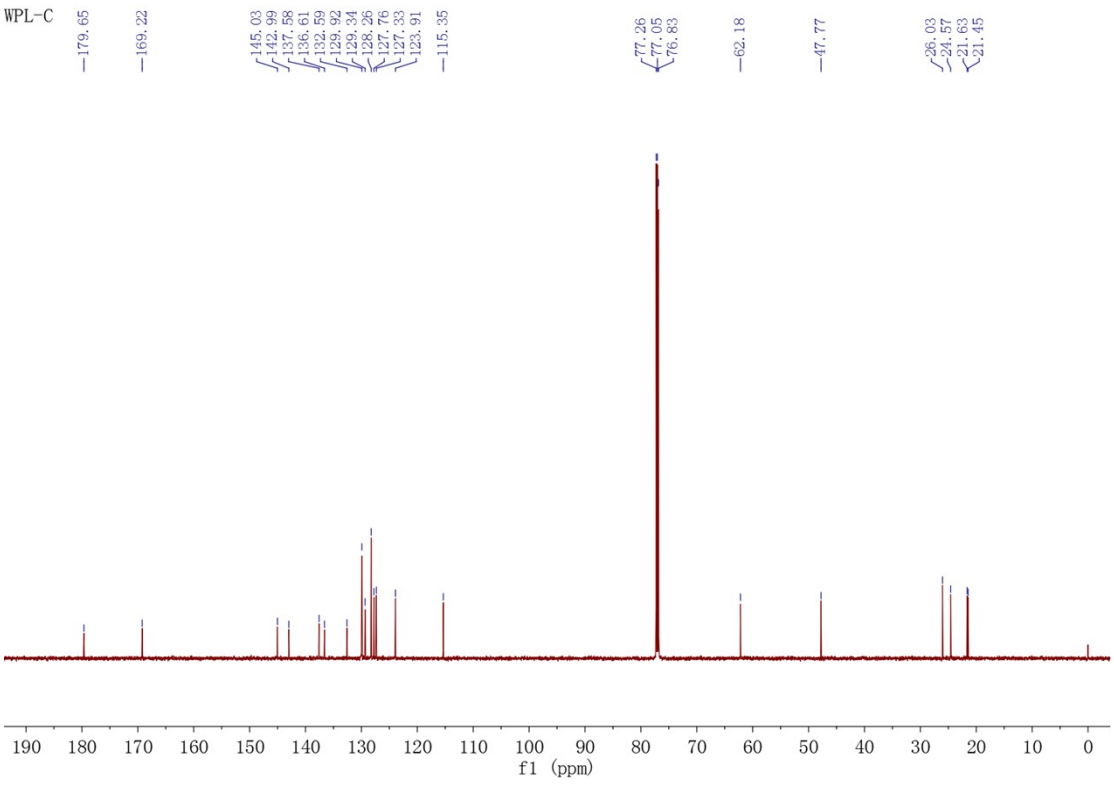

2.07
1.19
1.14
2.06
1.28
1.03
1.00
1.16
1.10
3.04
3.19
3.18
f1 (ppm)


WPL-C
179.33
169.17
145.20
141.52
136.52
134.71
131.45
129.99
129.66
129.33
128.18
125.56
121.91
116.51
77.23
77.02
76.81
62.16
47.79
25.89
24.44
21.66
0.00
f1 (ppm)


Ts
O
N
Ac
CH3

3j


WPL-H
7.72
7.71
7.29
7.27
7.26
7.24
7.23
7.17
7.16
7.05
7.02
7.01
5.49
3.70
3.67
3.47
3.45
2.49
2.42
2.37
1.39
2.17
2.07
0.89
1.10
1.01
0.97
1.00
1.06
1.15
3.09
3.18
3.11
3.15
f1 (ppm)


WPL-C
179.65
169.22
145.03
142.99
137.58
136.61
132.59
129.92
129.34
128.26
127.76
127.33
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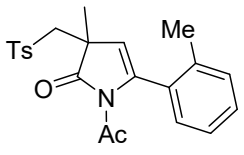
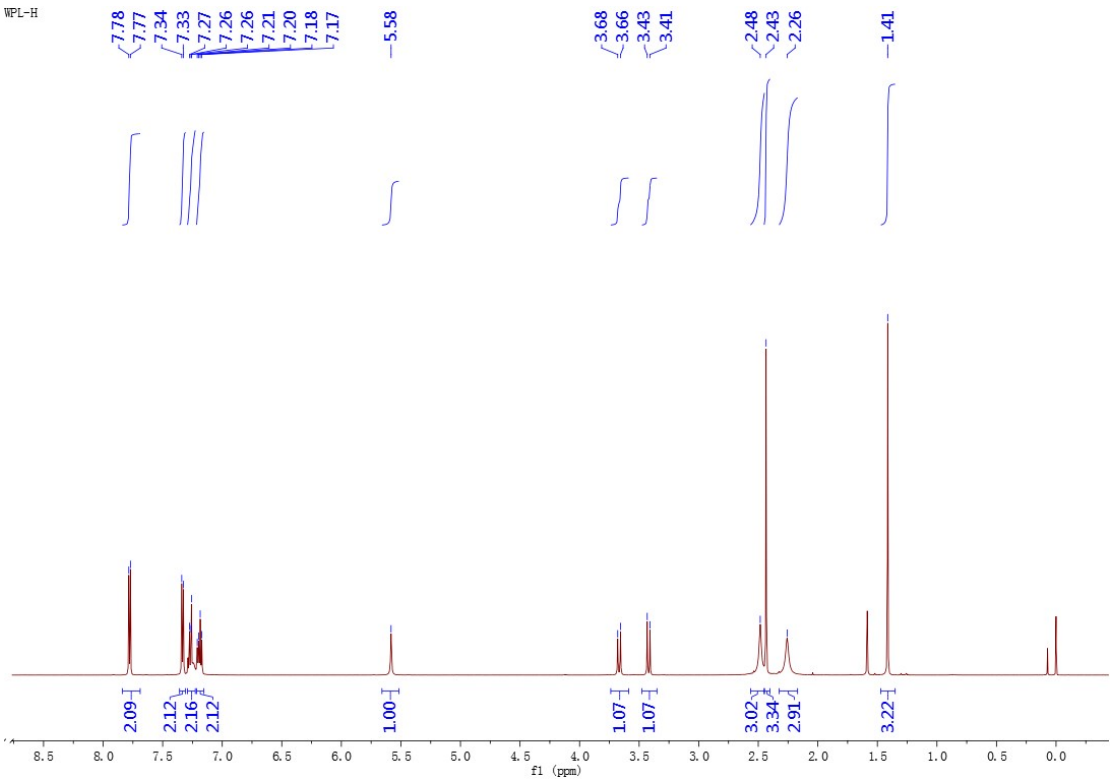
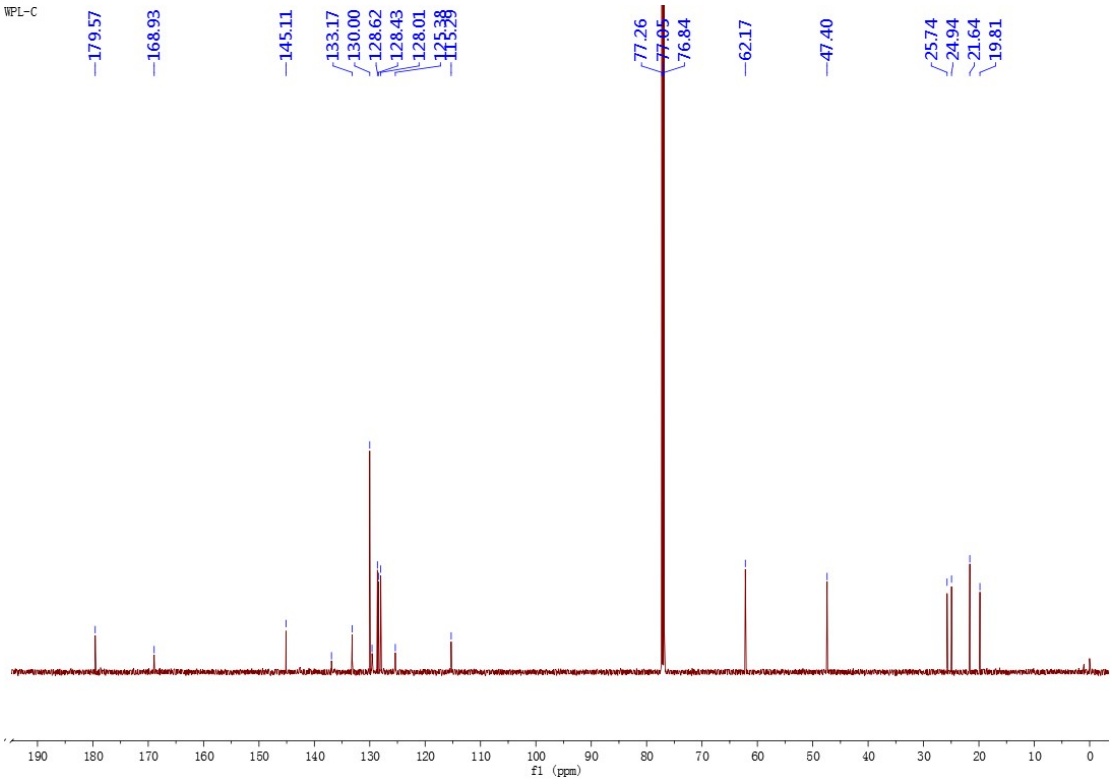
24.57
21.63
21.45
f1 (ppm)


Me
Ts
O
N
Ac

3l


WPL-H
7.78
7.77
7.34
7.33
7.27
7.26
7.26
7.21
7.20
7.18
7.17
5.58
3.68
3.66
3.43
3.41
2.48
2.43
2.26
1.41
2.09
2.12
2.16
2.12
1.00
1.07
1.07
3.02
3.34
2.91
3.22
f1 (ppm)


WPL-C
179.57
168.93
145.11
133.17
130.00
128.62
128.43
128.01
77.26
77.05
76.84
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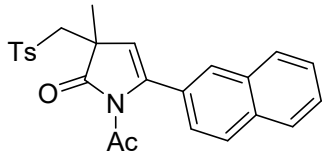
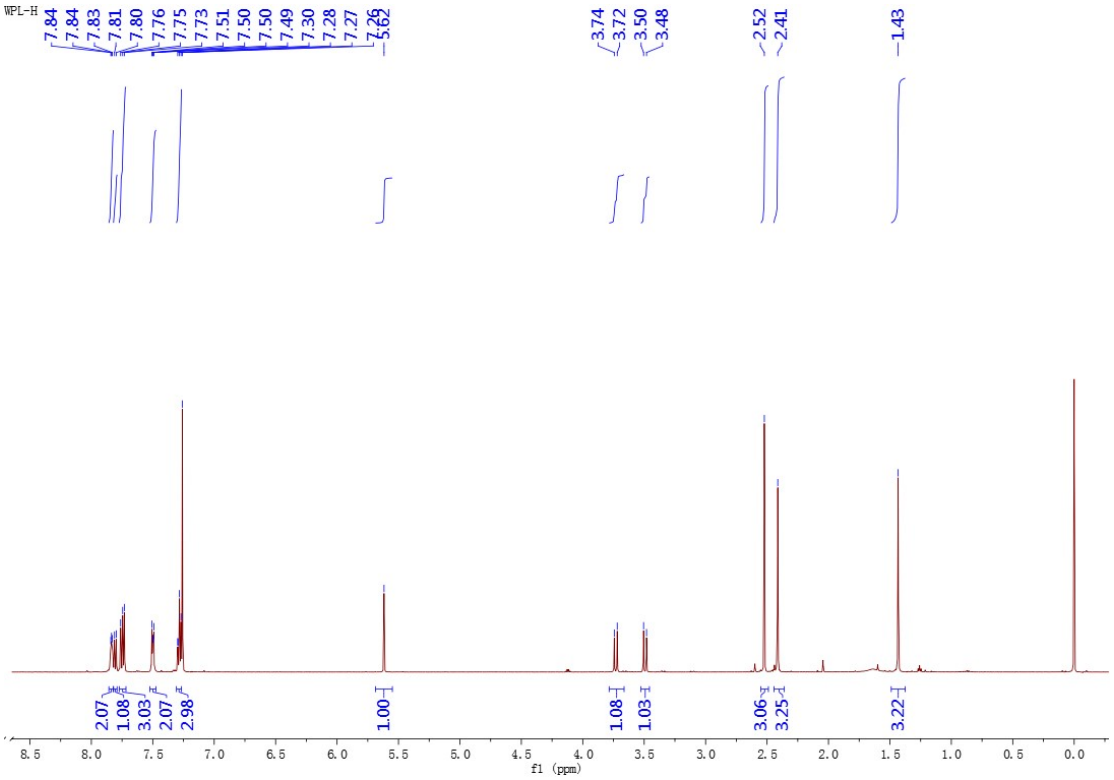
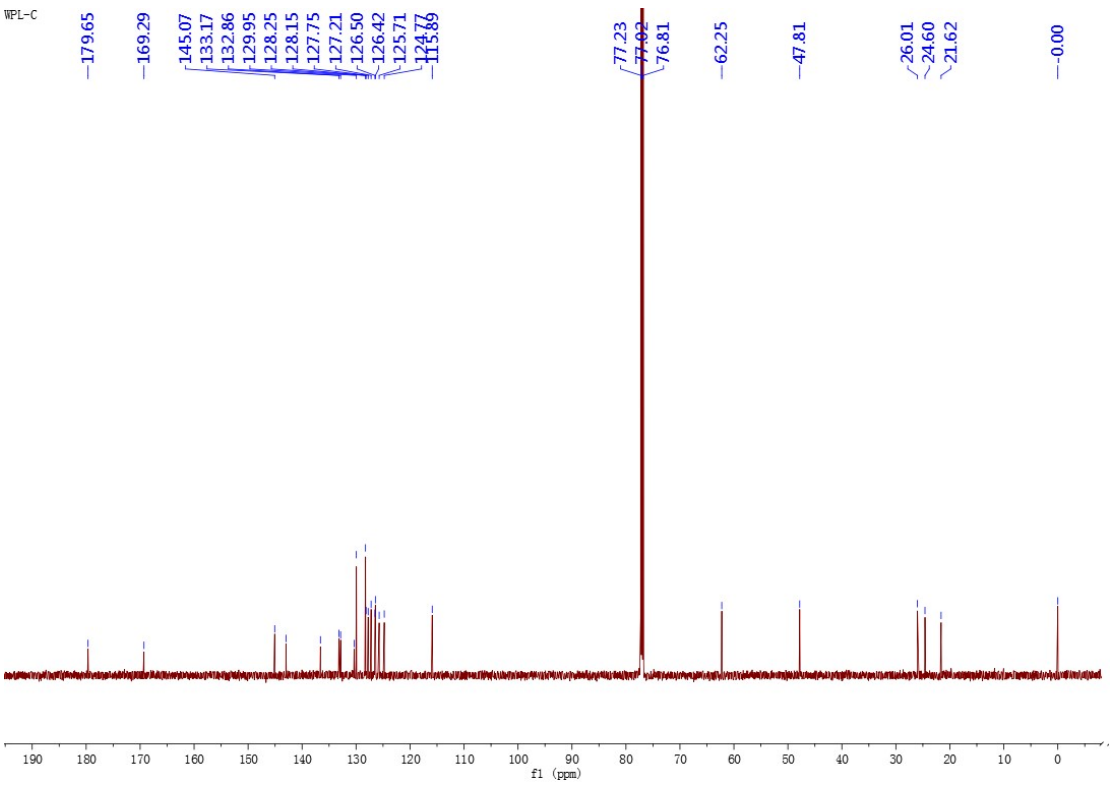
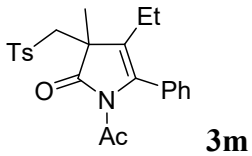
25.74
24.94
21.64
19.81
f1 (ppm)


Ts
O
N
Ac

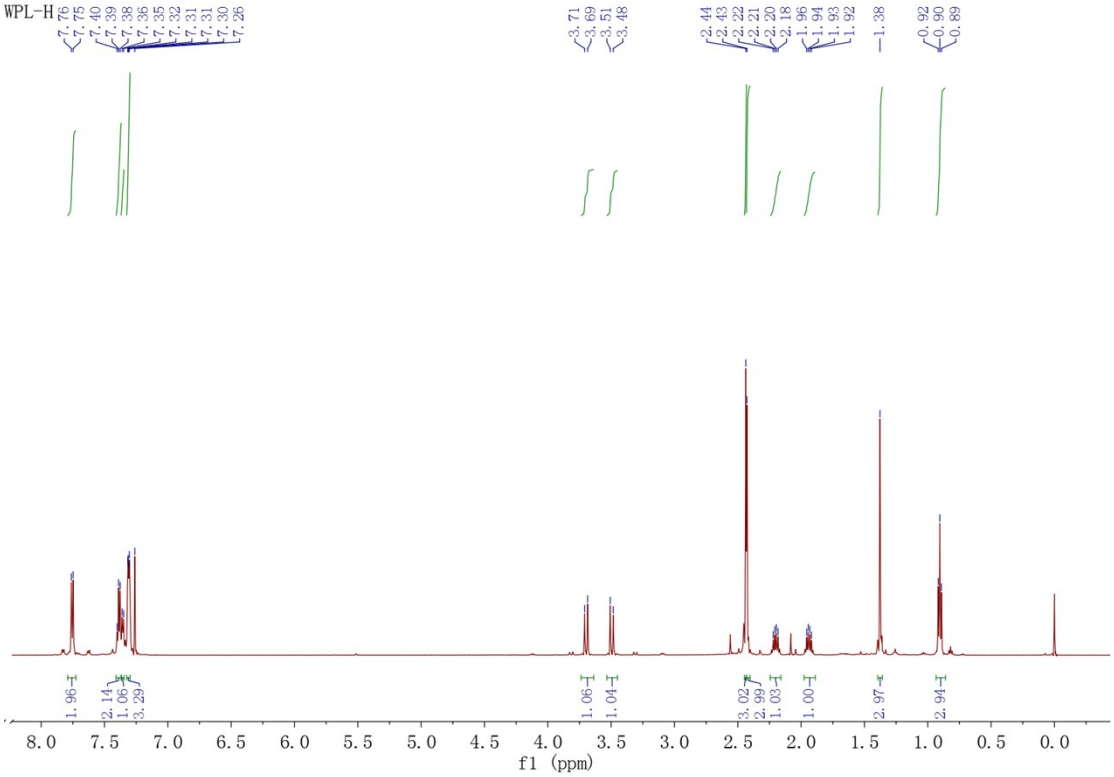
3l

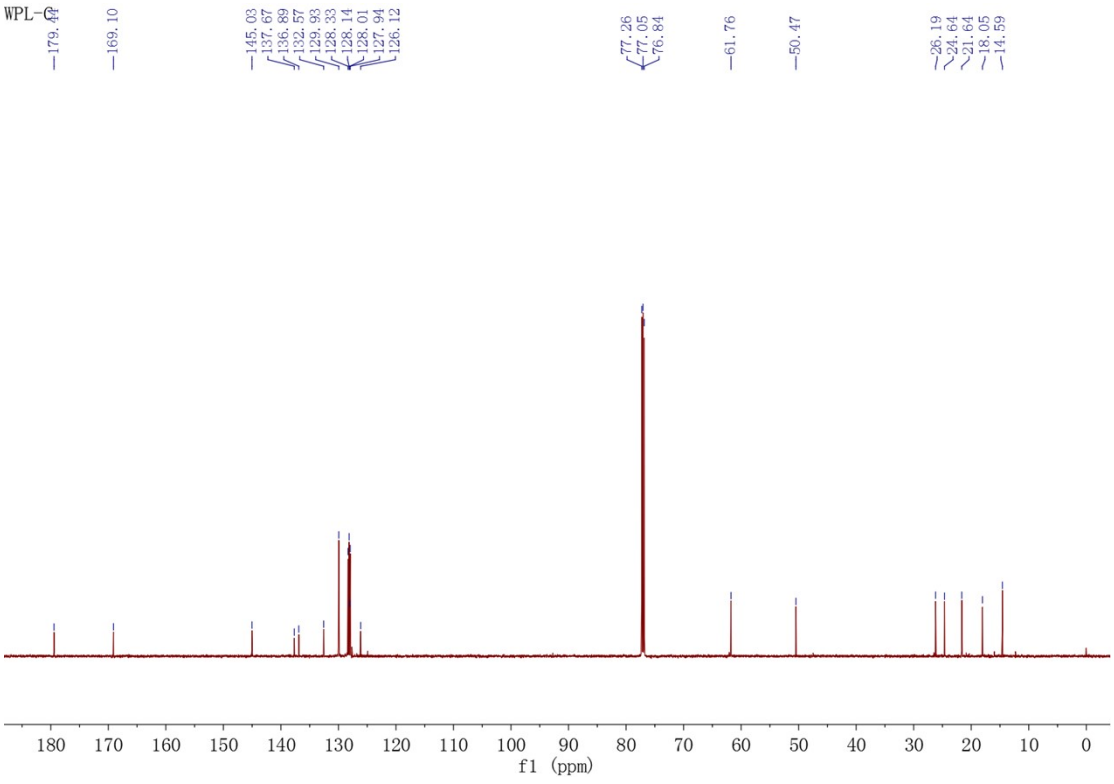

WPL-H
7.84
7.84
7.83
7.81
7.80
7.76
7.75
7.73
7.51
7.50
7.50
7.49
7.30
7.28
7.27
7.26
5.62
3.74
3.72
3.50
3.48
2.52
2.41
1.43
2.07
1.08
3.03
2.07
2.98
1.00
1.08
1.03
3.06
3.25
3.22
f1 (ppm)

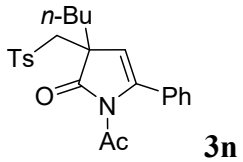

WPL-C
179.65
169.29
145.07
133.17
132.86
129.95
128.25
128.15
127.75
127.21
126.50
126.42
125.71
124.77
115.89
77.23
77.02
76.81
62.25
47.81
26.01
24.60
21.62
0.00
f1 (ppm)


Et
Ts
O
N
Ph
Ac

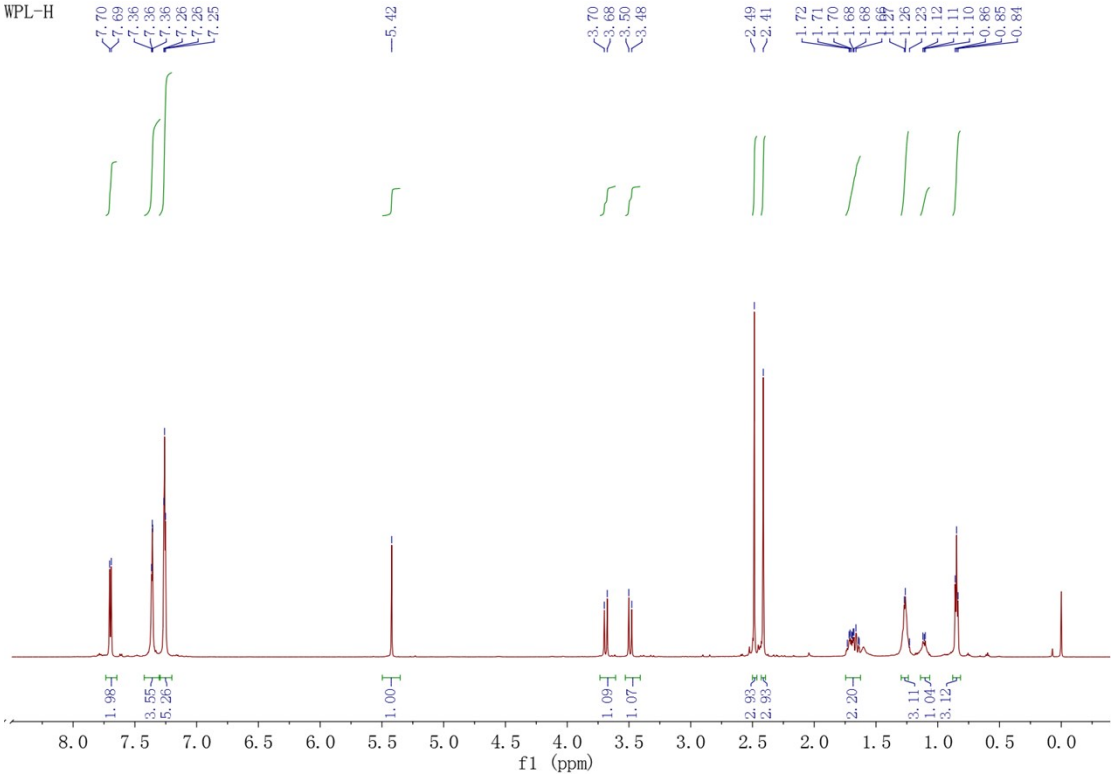
3m

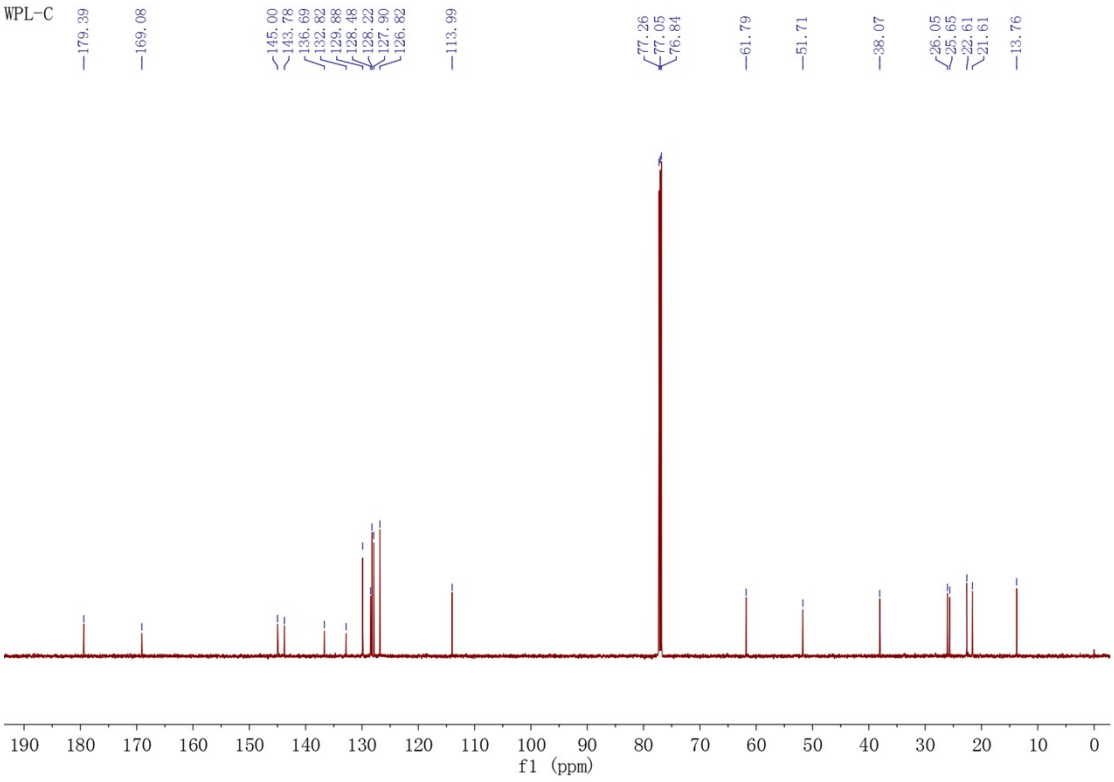

WPL-H
7.76
7.75
7.40
7.39
7.38
7.36
7.35
7.32
7.31
7.31
7.30
7.26
3.71
3.69
3.51
3.48
2.44
2.43
2.22
2.21
2.20
2.18
1.96
1.94
1.93
1.92
1.38
0.92
0.90
0.89
1.96
2.14
1.06
3.29
1.06
1.04
3.02
2.99
1.03
1.00
2.97
2.94
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

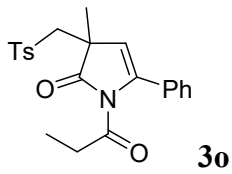

WPL-C
179.41
169.10
145.03
137.67
136.89
132.57
129.93
128.33
128.14
128.01
127.94
126.12
77.26
77.05
76.84
61.76
50.47
26.19
24.64
21.64
18.05
14.59
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


n-Bu
Ts
O
N
Ph
Ac

3n

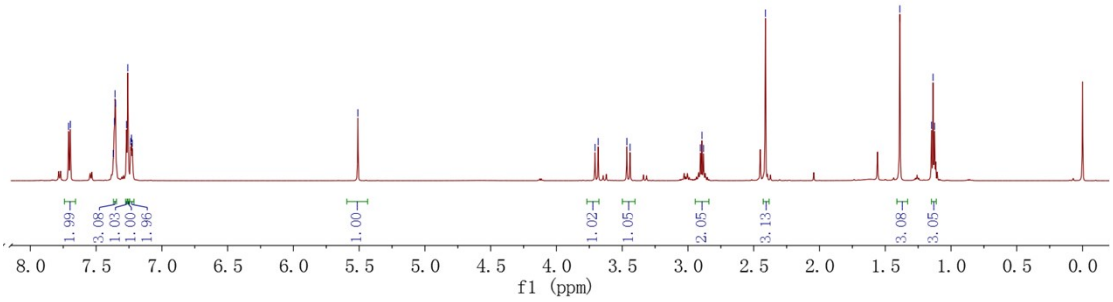

WPL-H
7.70
7.69
7.36
7.36
7.36
7.26
7.26
7.25
5.42
3.70
3.68
3.50
3.48
2.49
2.41
1.72
1.71
1.70
1.68
1.68
1.66
1.27
1.26
1.23
1.12
1.11
1.10
0.86
0.85
0.84
1.98
3.55
5.26
1.00
1.09
1.07
2.93
2.93
2.20
3.11
1.04
3.12
8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)


WPL-C
179.39
169.08
145.00
143.78
136.69
132.82
129.88
128.48
128.22
127.90
126.82
113.99
77.26
77.05
76.84
61.79
51.71
38.07
26.05
25.65
22.61
21.61
13.76
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

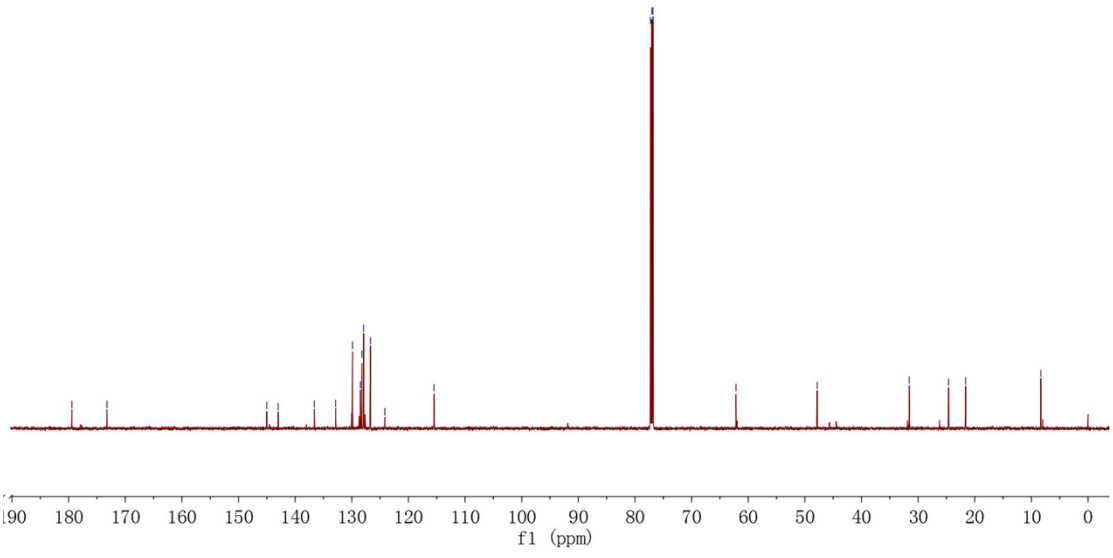

Ts
O
N
Ph
O

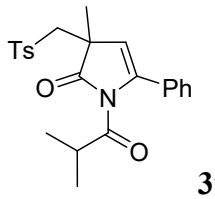
3o


WPL-H
7.71
7.70
7.37
7.36
7.36
7.35
7.27
7.26
7.24
7.23
7.23
5.51
3.71
3.68
3.46
3.44
2.91
2.89
2.88
2.41
1.39
1.15
1.14
1.12

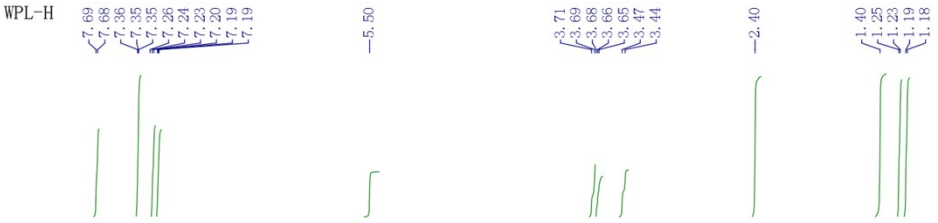

1.99
3.08
1.03
1.00
1.96
1.00
1.02
1.05
2.05
3.13
3.08
3.05
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

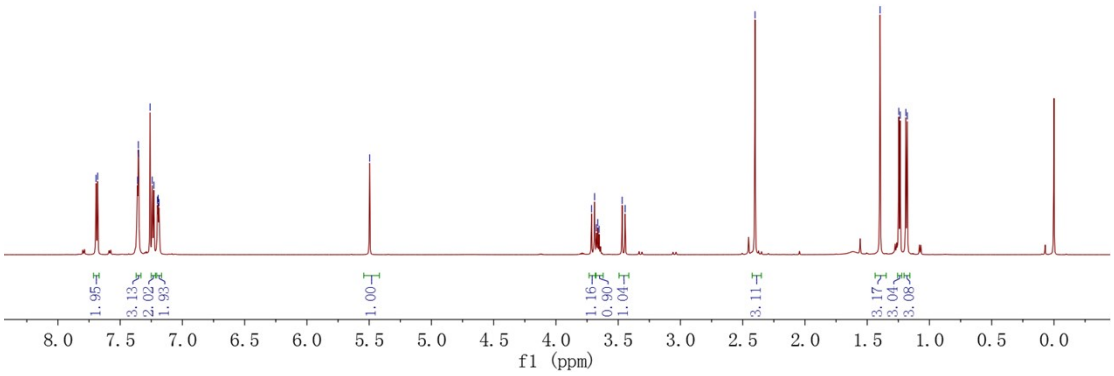

WPL-C
179.42
173.23
145.03
143.01
136.61
132.86
129.87
128.47
128.22
127.93
126.71
124.16
115.49
77.24
77.03
76.82
62.16
47.83
31.58
24.63
21.62
8.33

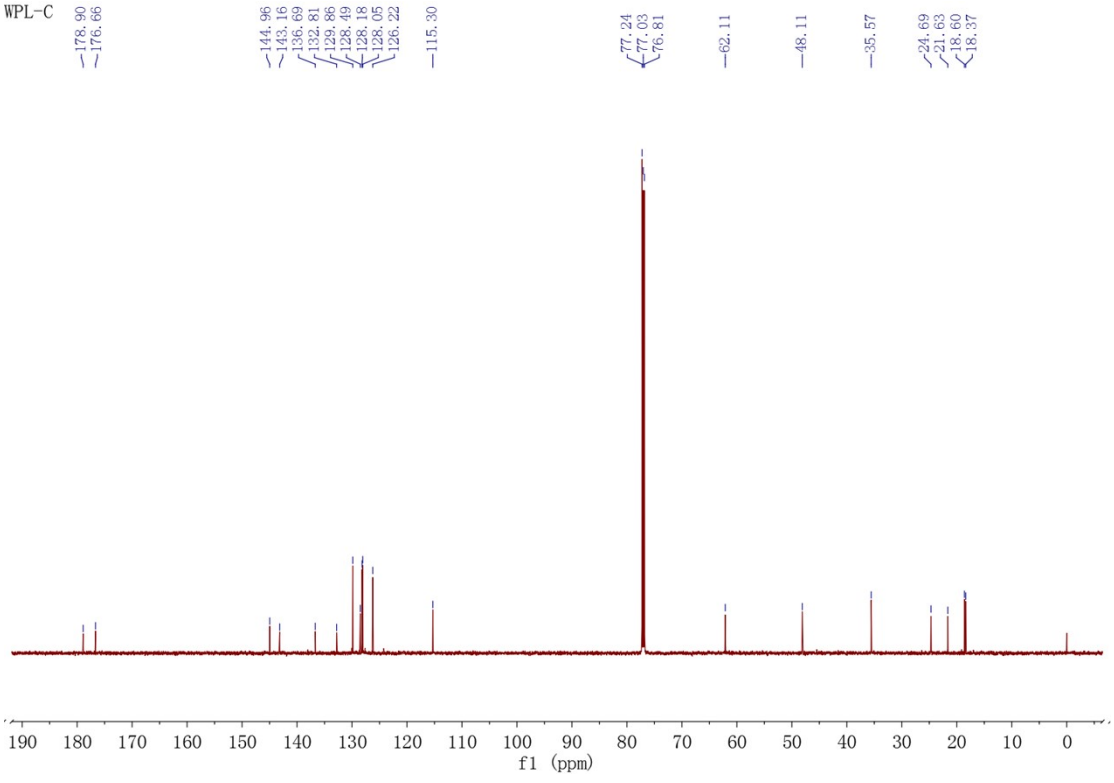

190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

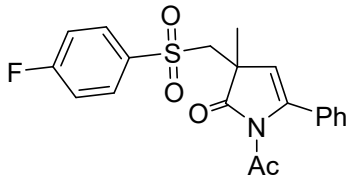

Ts
O
N
Ph
O

3p

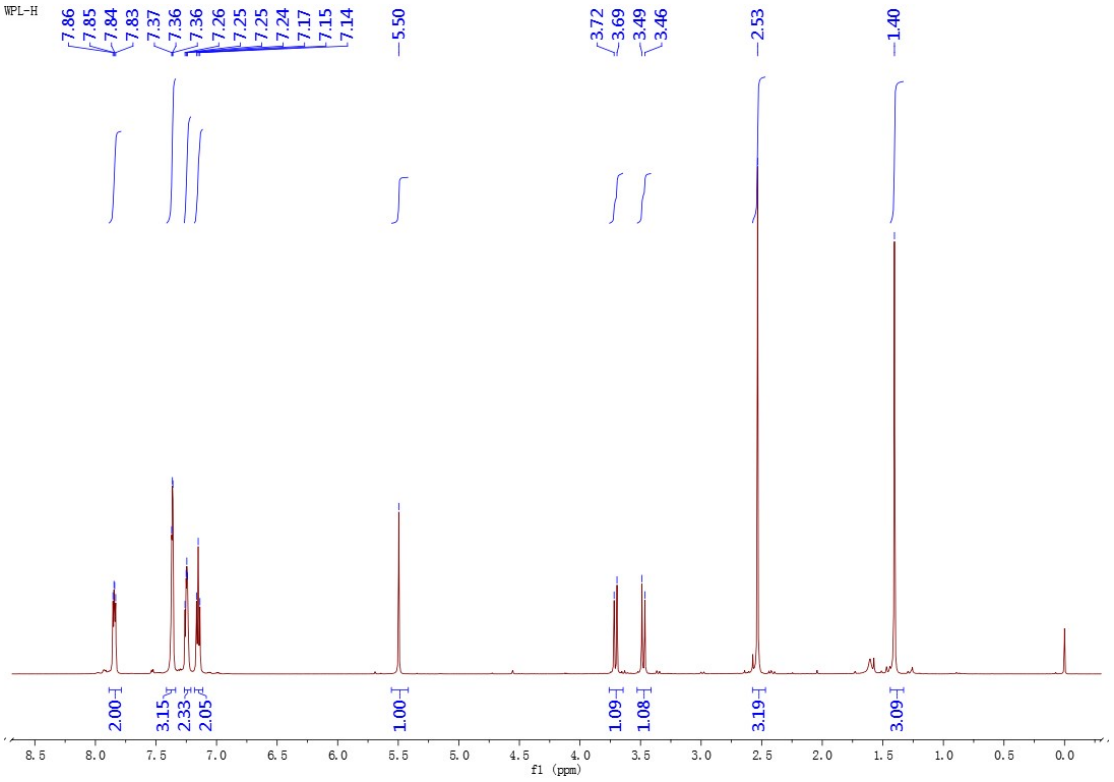

WPL-H
7.69
7.68
7.36
7.35
7.35
7.26
7.24
7.23
7.20
7.19
7.19
5.50
3.71
3.69
3.68
3.66
3.65
3.47
3.44
2.40
1.40
1.25
1.23
1.19
1.18

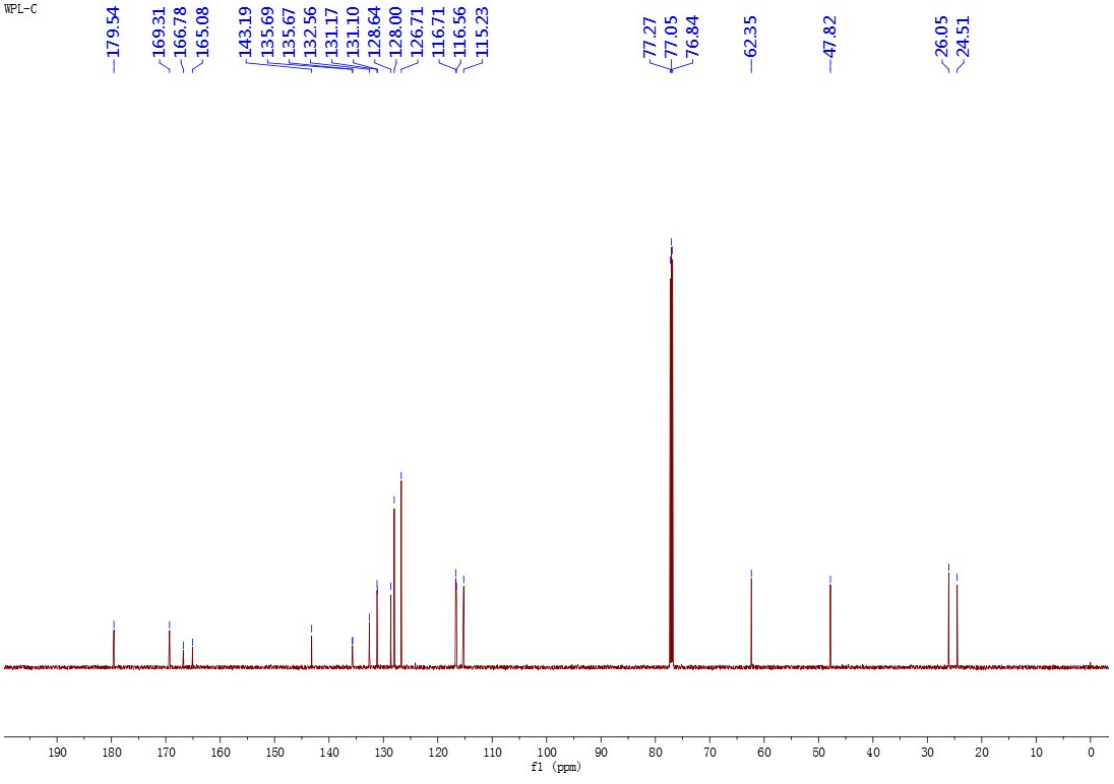

1.95
3.13
2.02
1.93
1.00
1.16
0.90
1.04
3.11
3.17
3.04
3.08
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

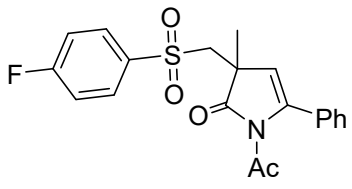

WPL-C
178.90
176.66
144.96
143.16
136.69
132.81
129.86
128.49
128.18
128.05
126.22
115.30
77.24
77.03
76.81
62.11
48.11
35.57
24.69
21.63
18.60
18.37
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


F
O
S
O
O
N
Ac
Ph

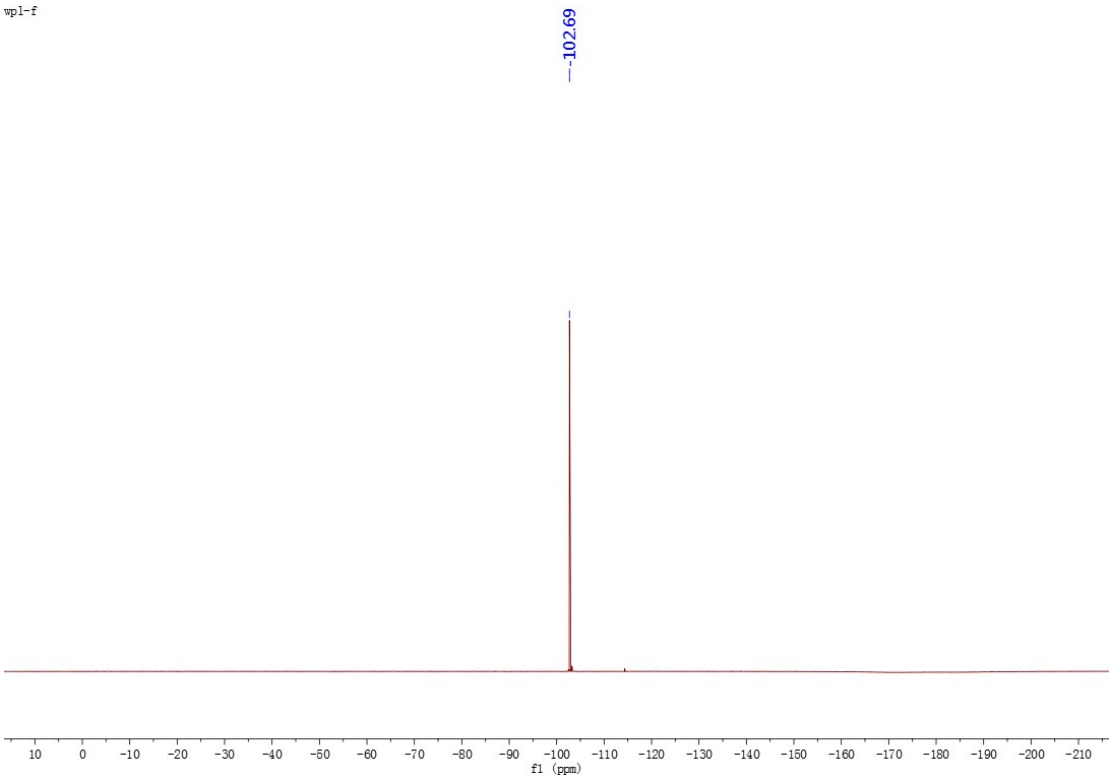
4a

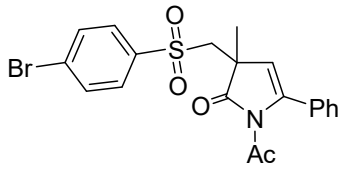

WPL-H
7.86
7.85
7.84
7.83
7.37
7.36
7.36
7.26
7.25
7.25
7.24
7.17
7.15
7.14
5.50
3.72
3.69
3.49
3.46
2.53
1.40
2.00
3.15
2.33
2.05
1.00
1.09
1.08
3.19
3.09
f1 (ppm)


WPL-C
179.54
169.31
166.78
165.08
143.19
135.69
135.67
132.56
131.17
131.10
128.64
128.00
126.71
116.71
116.56
115.23
77.27
77.05
76.84
62.35
47.82
26.05
24.51
f1 (ppm)

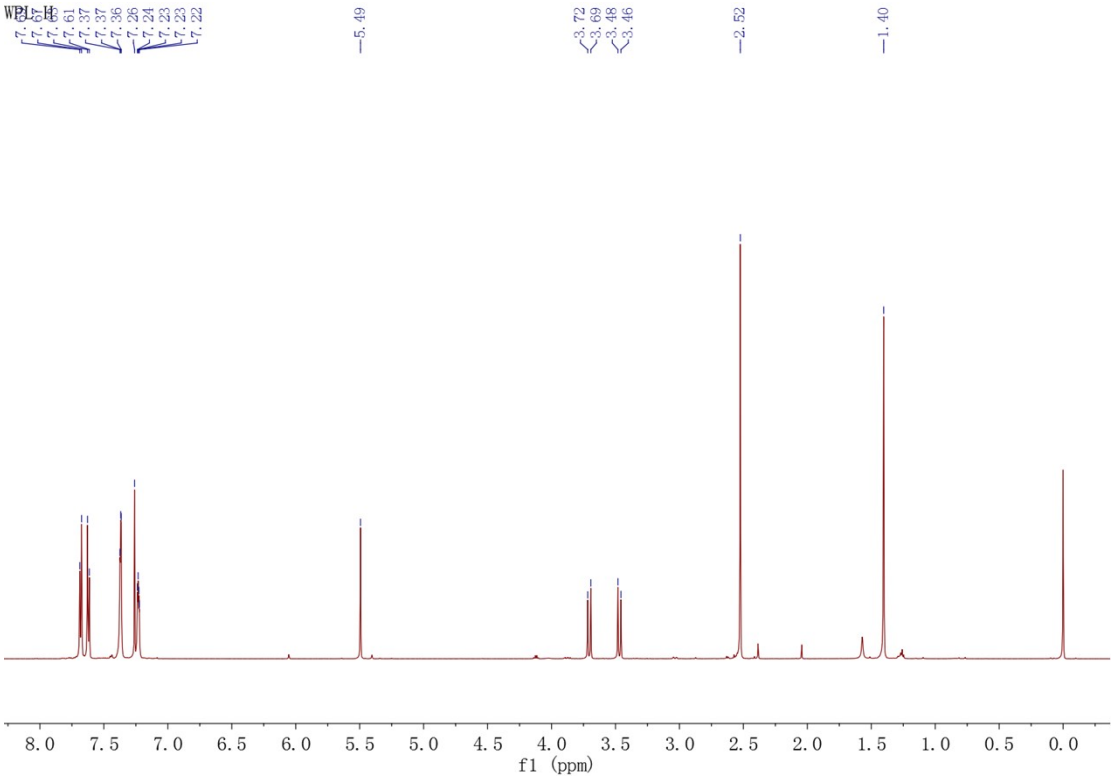

O
S
O
F
O
N
Ac
Ph

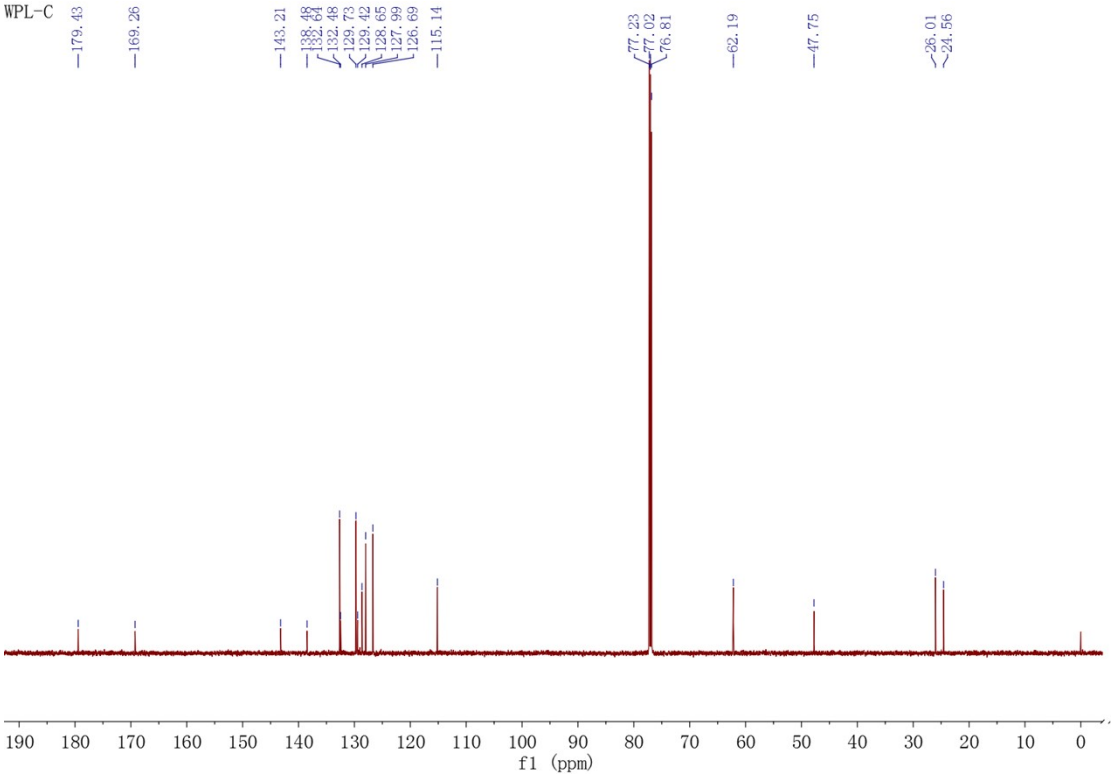
4a

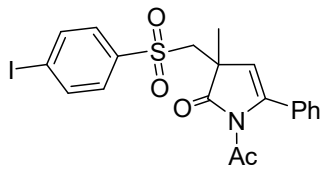

wp1-f
-102.69
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
-200
-210
f1 (ppm)


Br
O
S
O
O
N
Ac
Ph

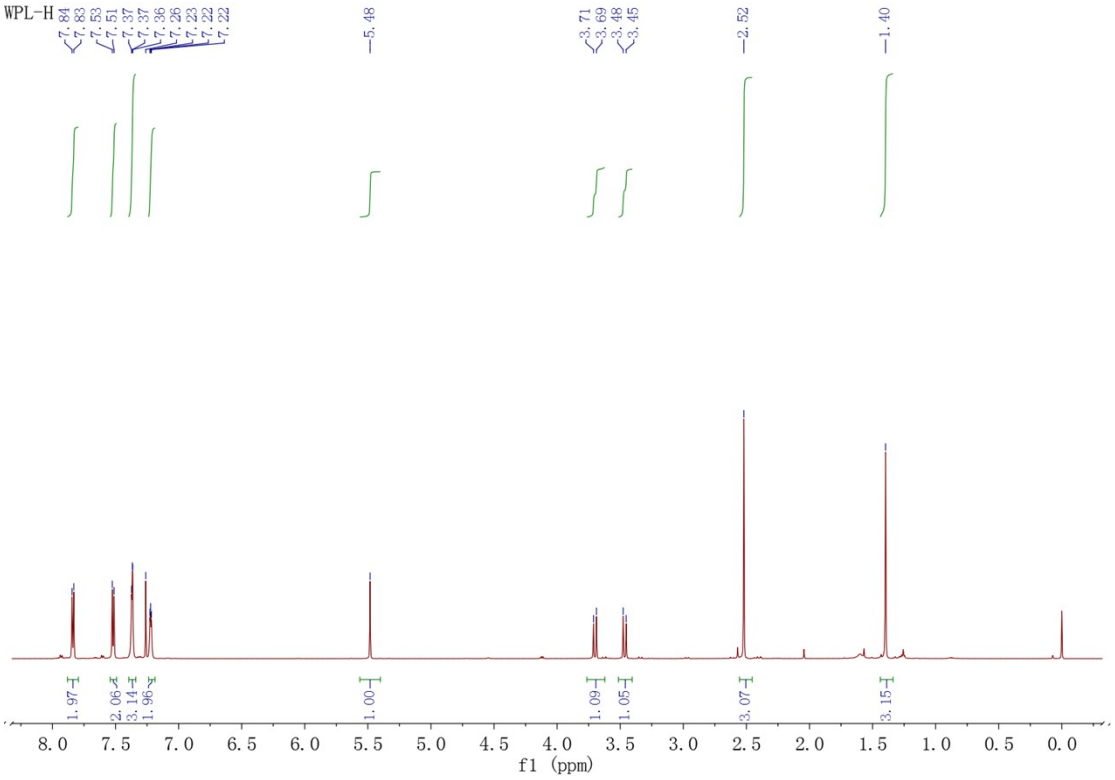
4b

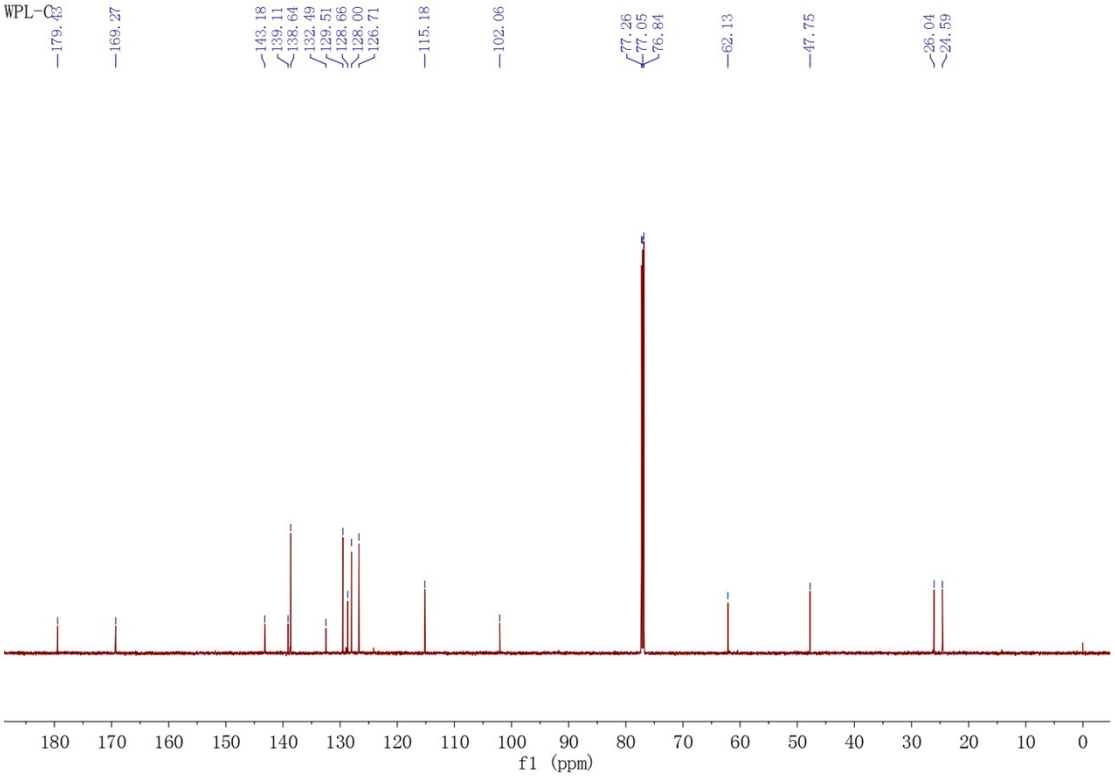

WPL-H
7.67
7.66
7.61
7.37
7.37
7.36
7.26
7.24
7.23
7.23
7.22
5.49
3.72
3.69
3.48
3.46
2.52
1.40
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

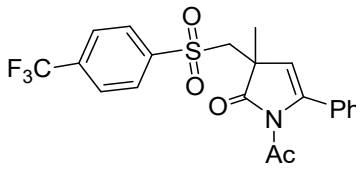

WPL-C
179.43
169.26
143.21
138.48
132.61
132.48
129.73
129.42
128.65
127.99
126.69
115.14
77.23
77.02
76.81
62.19
47.75
26.01
24.56
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


I
O
S
O
O
N
Ac
Ph

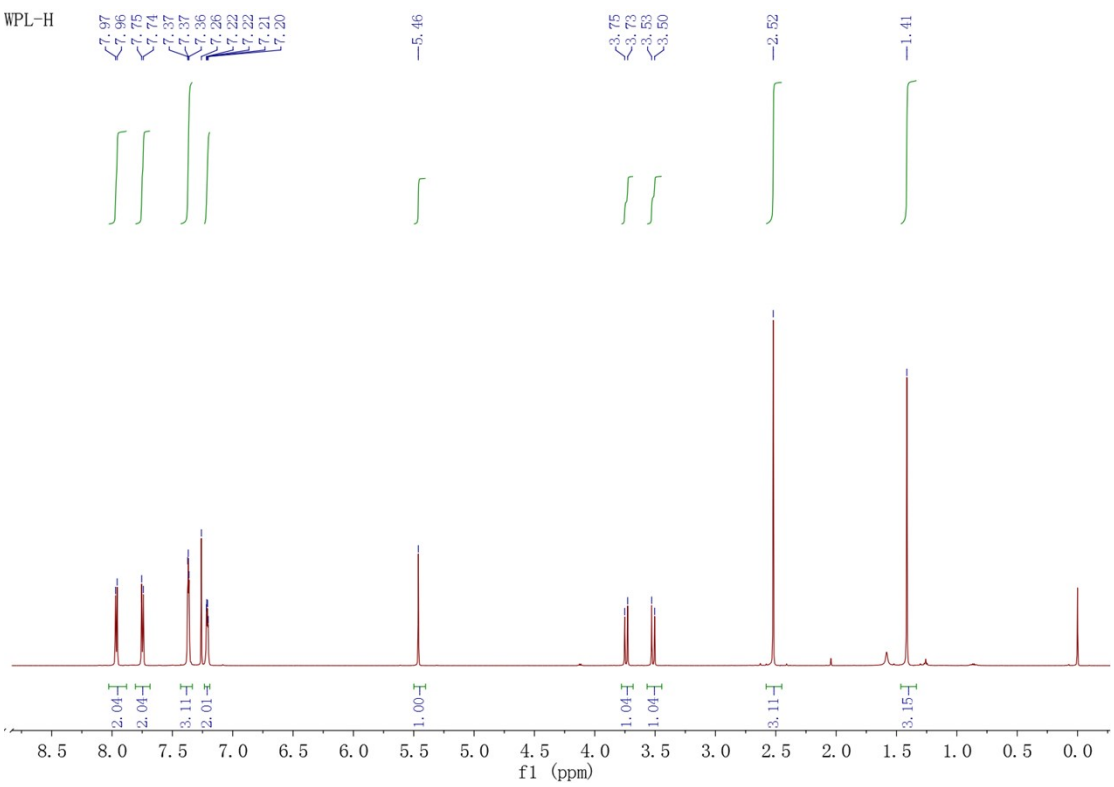
4c

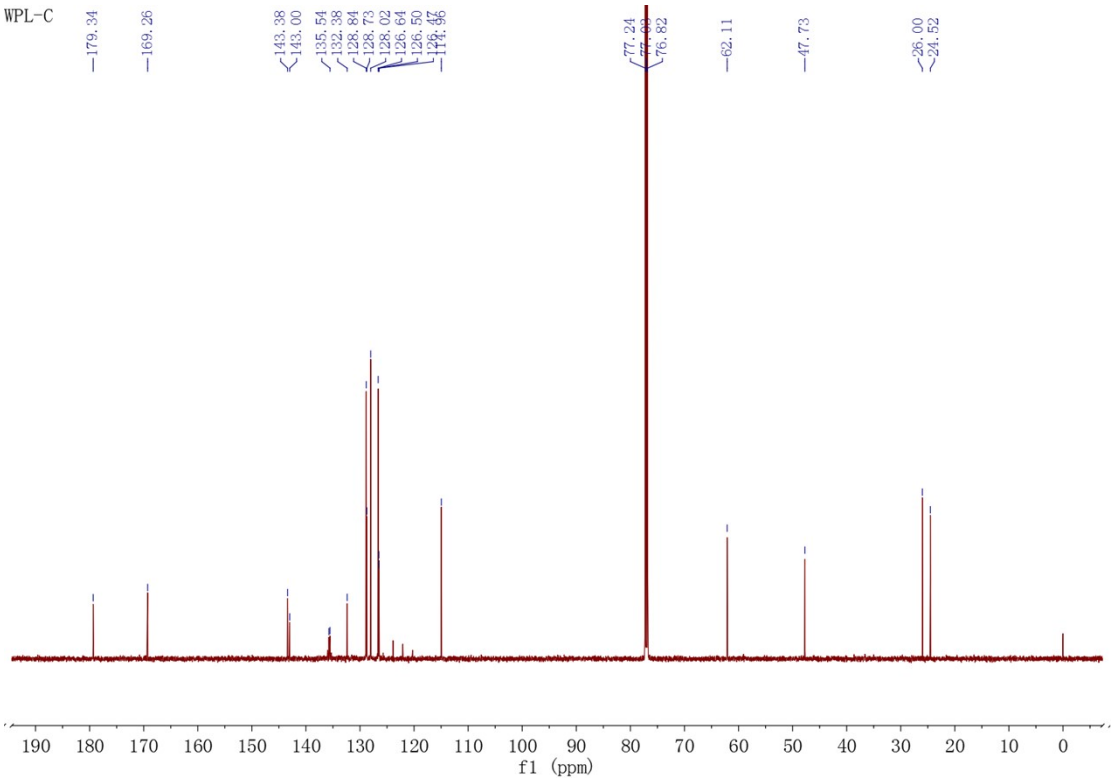

WPL-H
7.84
7.83
7.53
7.51
7.37
7.37
7.37
7.36
7.26
7.23
7.22
7.22
5.48
3.71
3.69
3.48
3.45
2.52
1.40
1.97
2.06
3.14
1.96
1.00
1.09
1.05
3.07
3.15
8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

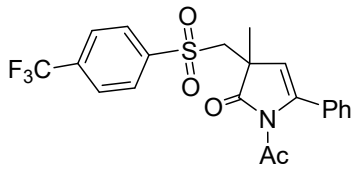

WPL-C
179.43
169.27
143.18
139.11
138.64
132.49
129.51
128.66
128.00
126.71
115.18
102.06
77.26
77.05
76.84
62.13
47.75
26.04
24.59
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


F3C
O
S
O
O
N
Ac
Ph

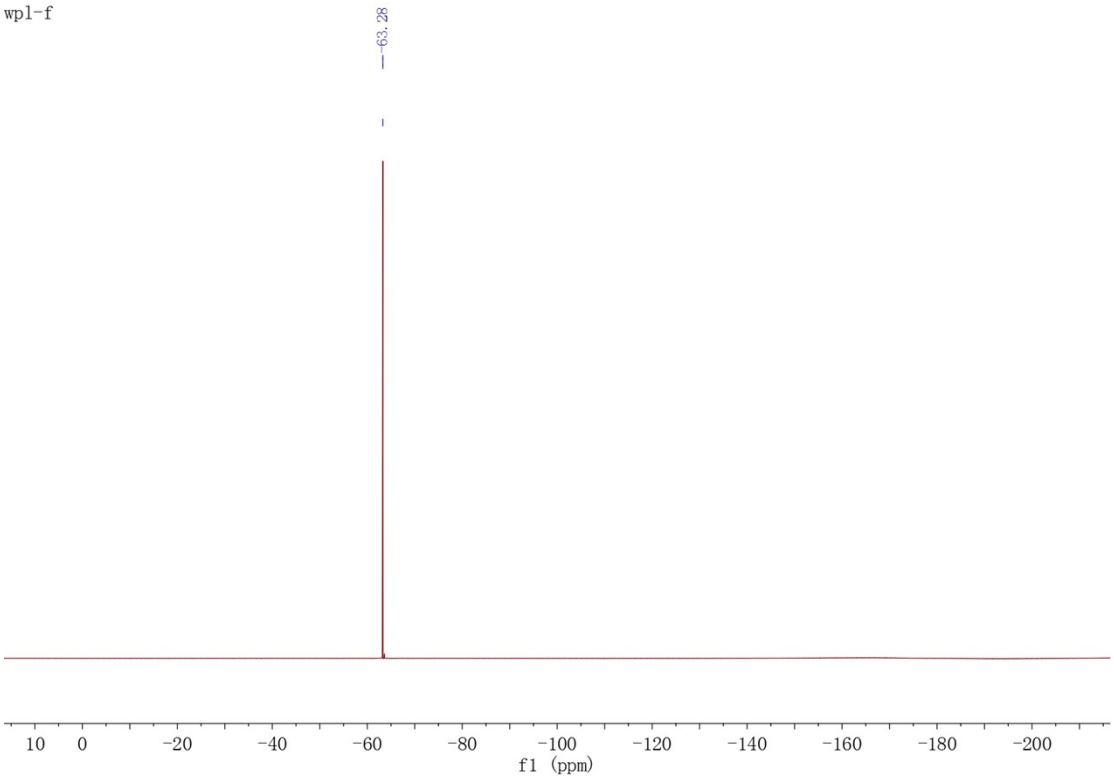
4d

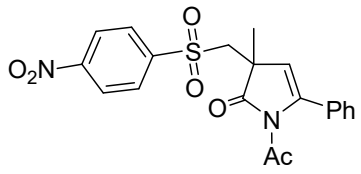

WPL-H
7.97
7.96
7.75
7.74
7.37
7.37
7.36
7.26
7.22
7.22
7.21
7.20
5.46
3.75
3.73
3.53
3.50
2.52
1.41
2.04
2.04
3.11
2.01
1.00
1.04
1.04
3.11
3.15
f1 (ppm)


WPL-C
179.34
169.26
143.38
143.00
135.54
132.38
128.84
128.73
128.02
126.64
126.50
126.47
114.96
77.24
77.03
76.82
62.11
47.73
26.00
24.52
f1 (ppm)

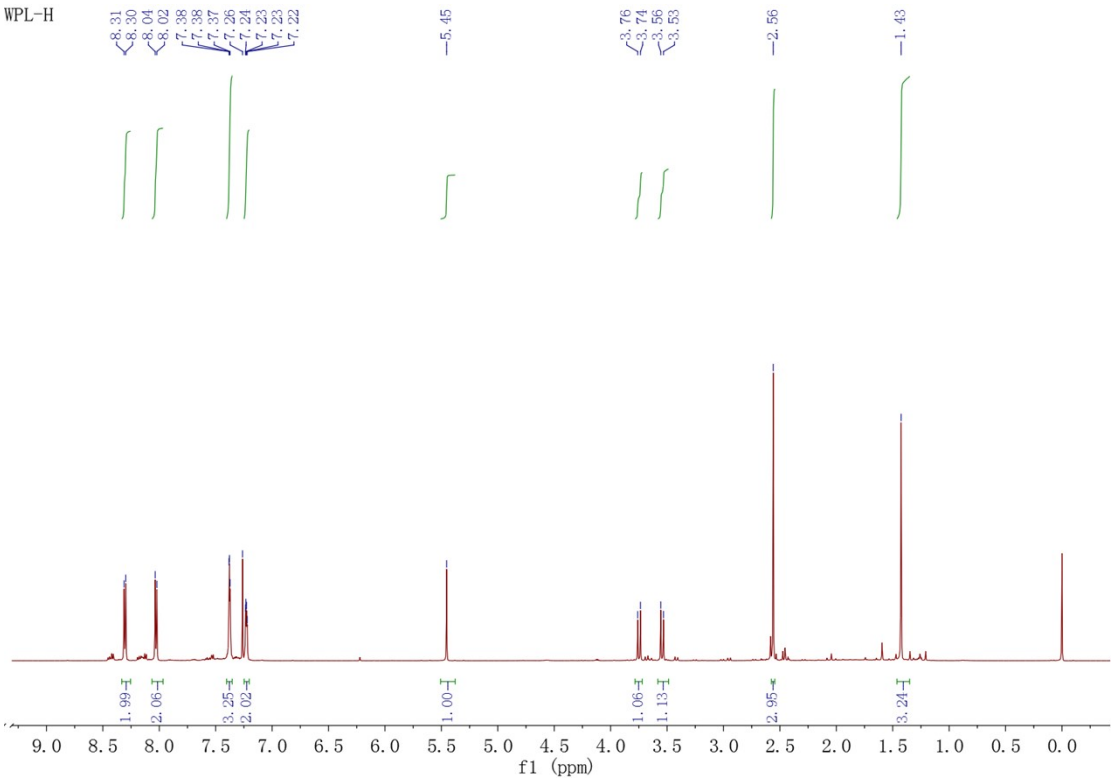

O
S
O
F3C
O
N
Ac
Ph

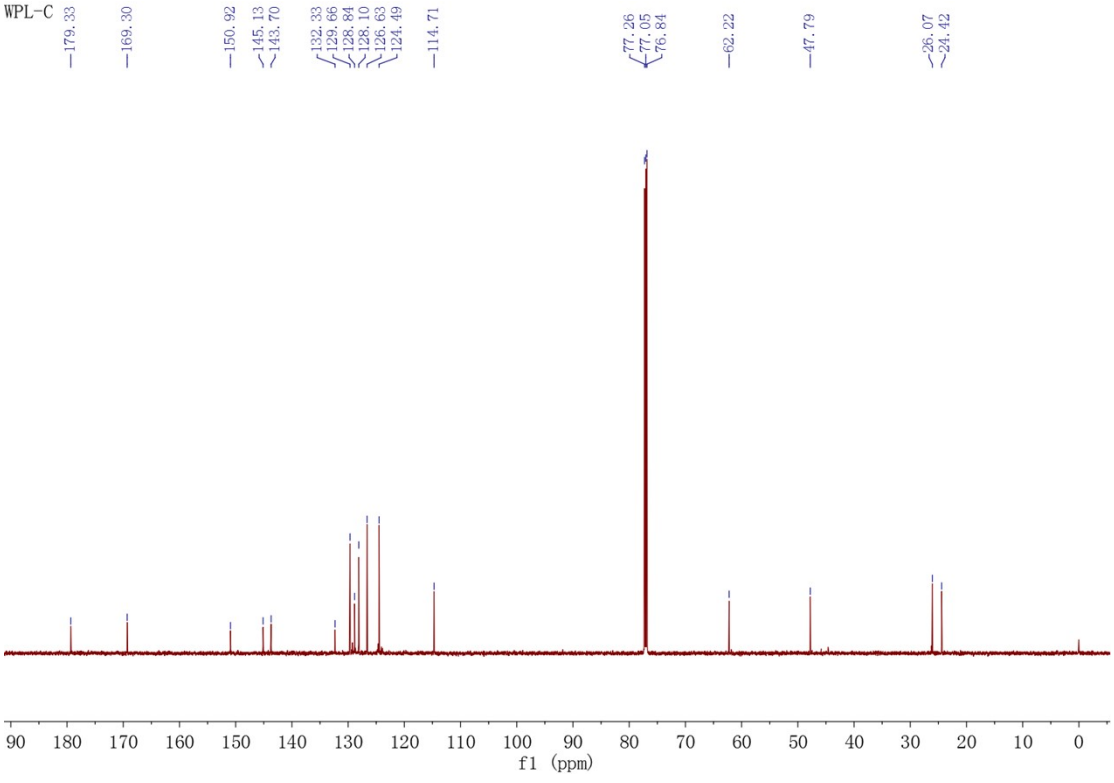
4d

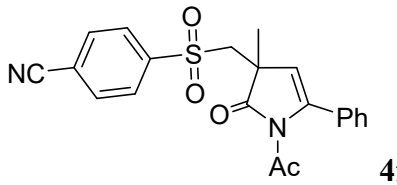

wpl-f
-63.28
10
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
f1 (ppm)


O2N
O
S
O
O
N
Ac
Ph

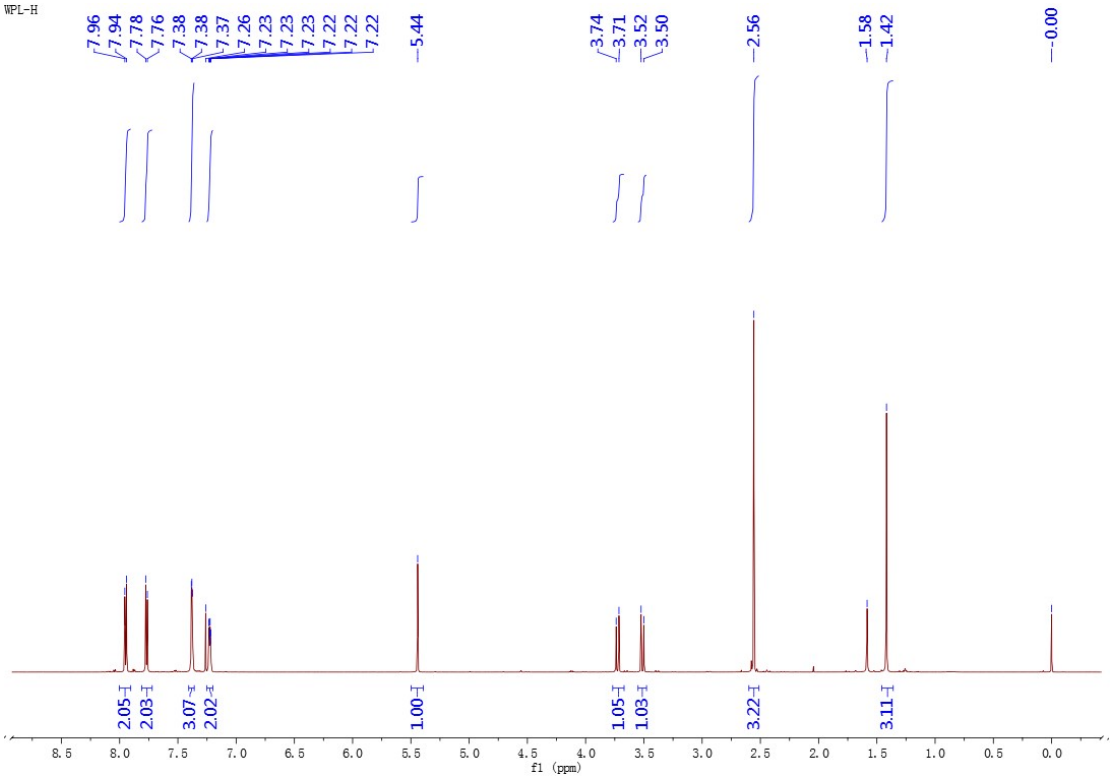
4e

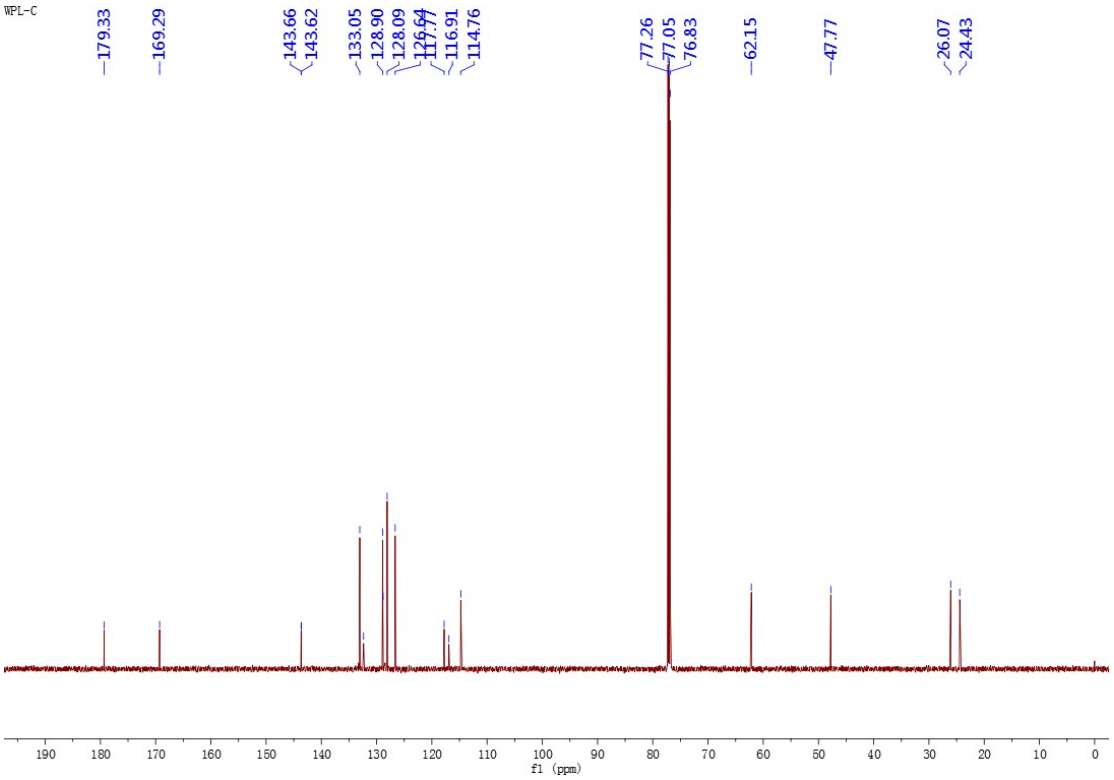

WPL-H
8.31
8.30
8.04
8.02
7.38
7.38
7.37
7.26
7.24
7.23
7.23
7.22
5.45
3.76
3.74
3.56
3.53
2.56
1.43
1.99
2.06
3.25
2.02
1.00
1.06
1.13
2.95
3.24
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

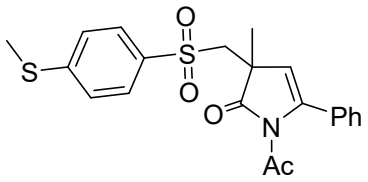

WPL-C
179.33
169.30
150.92
145.13
143.70
132.33
129.66
128.84
128.10
126.63
124.49
114.71
77.26
77.05
76.84
62.22
47.79
26.07
24.42
90 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


NC
O
S
O
O
N
Ac
Ph

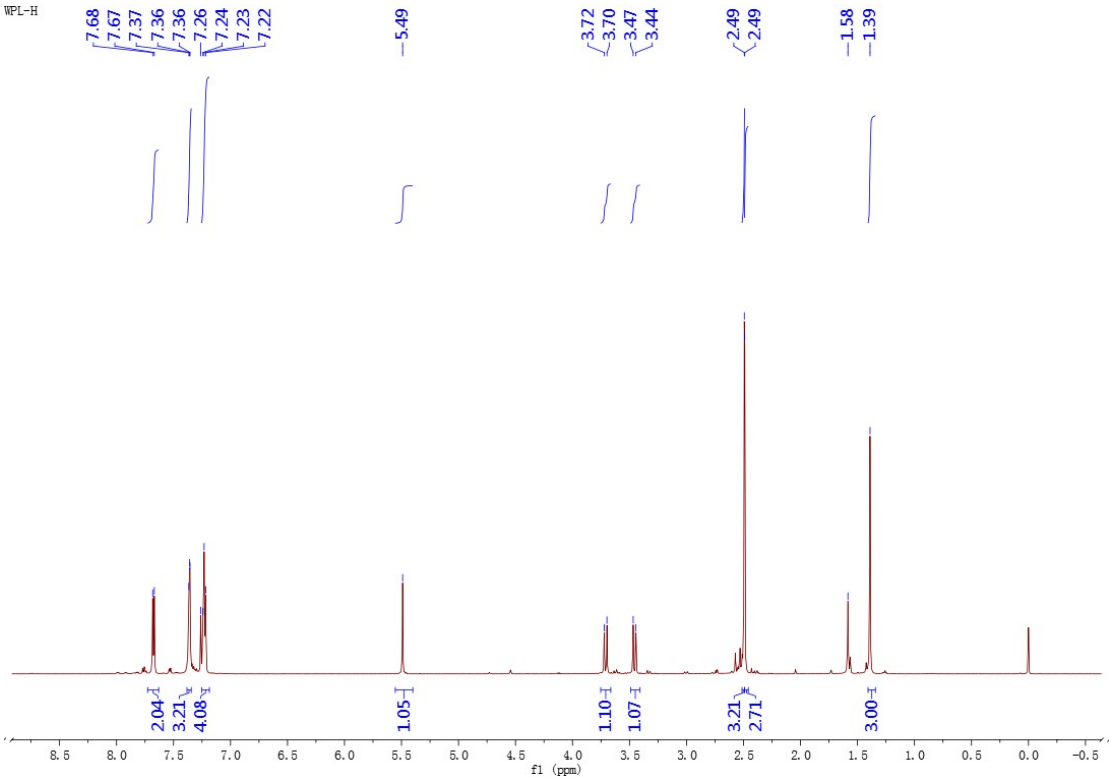
4f

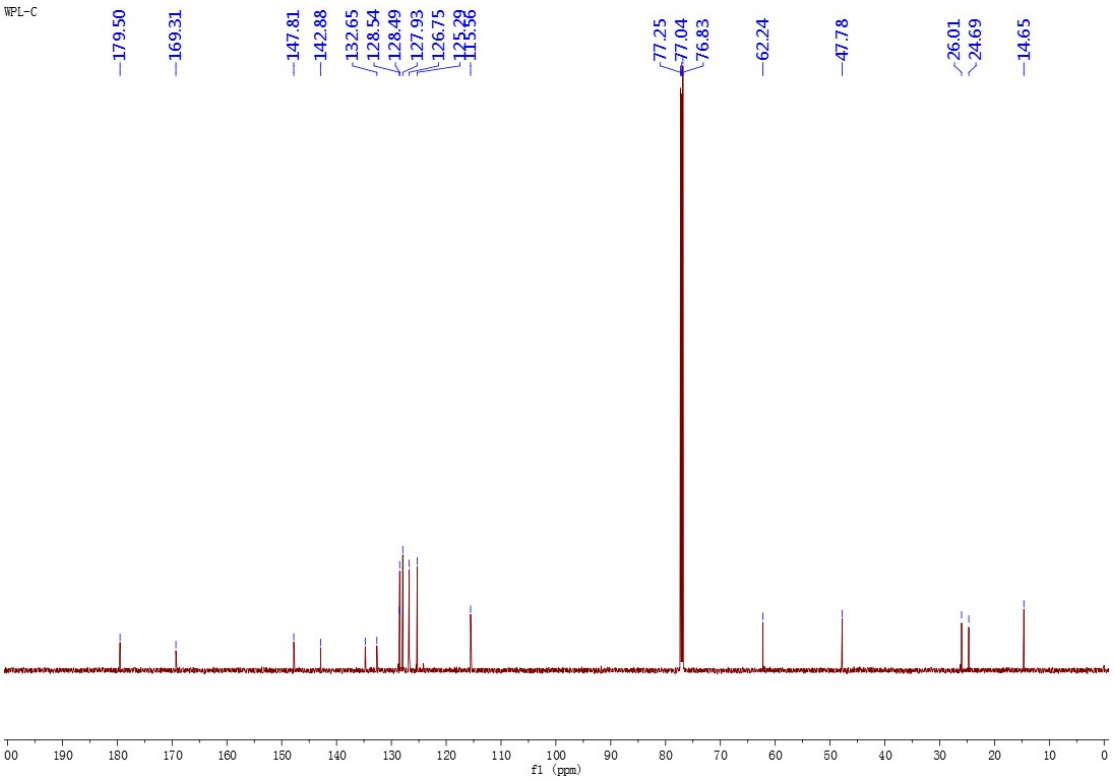

WPL-H
7.96
7.94
7.78
7.76
7.38
7.38
7.37
7.26
7.23
7.23
7.23
7.22
7.22
7.22
5.44
3.74
3.71
3.52
3.50
2.56
1.58
1.42
0.00
2.05
2.03
3.07
2.02
1.00
1.05
1.03
3.22
3.11
f1 (ppm)

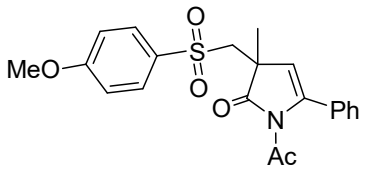

WPL-C
179.33
169.29
143.66
143.62
133.05
128.90
128.09
126.64
117.77
116.91
114.76
77.26
77.05
76.83
62.15
47.77
26.07
24.43
f1 (ppm)


O
S
O
S
O
O
N
Ac
Ph

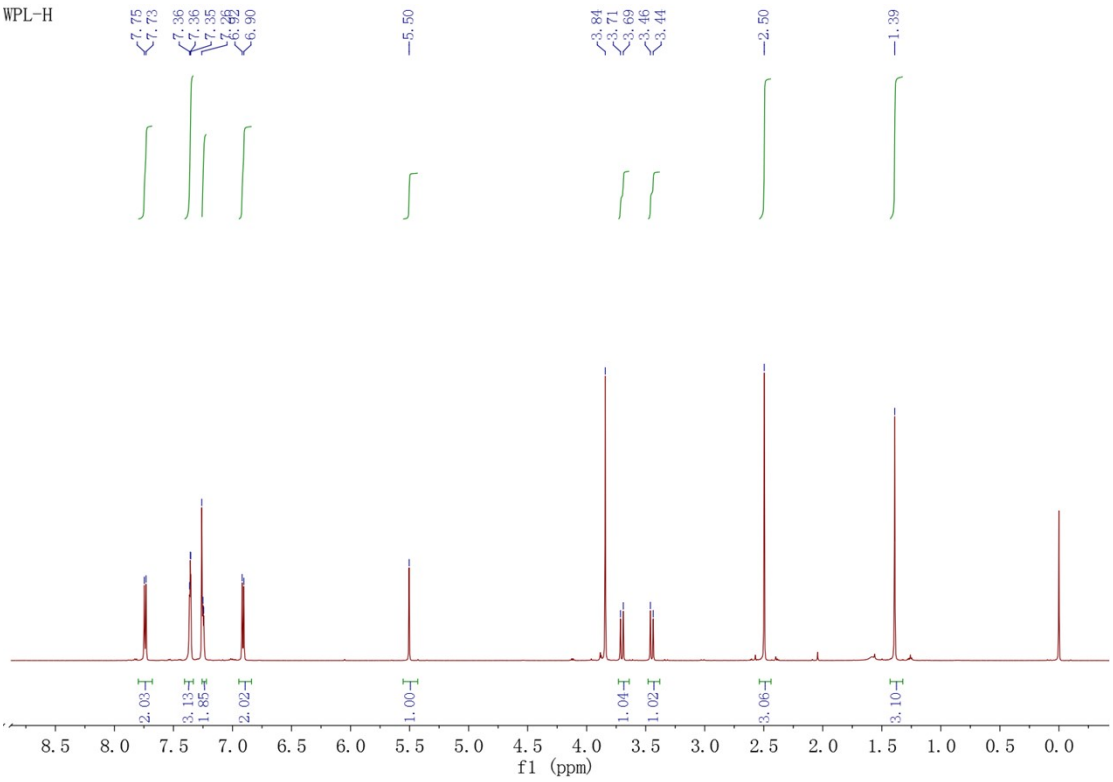
4g

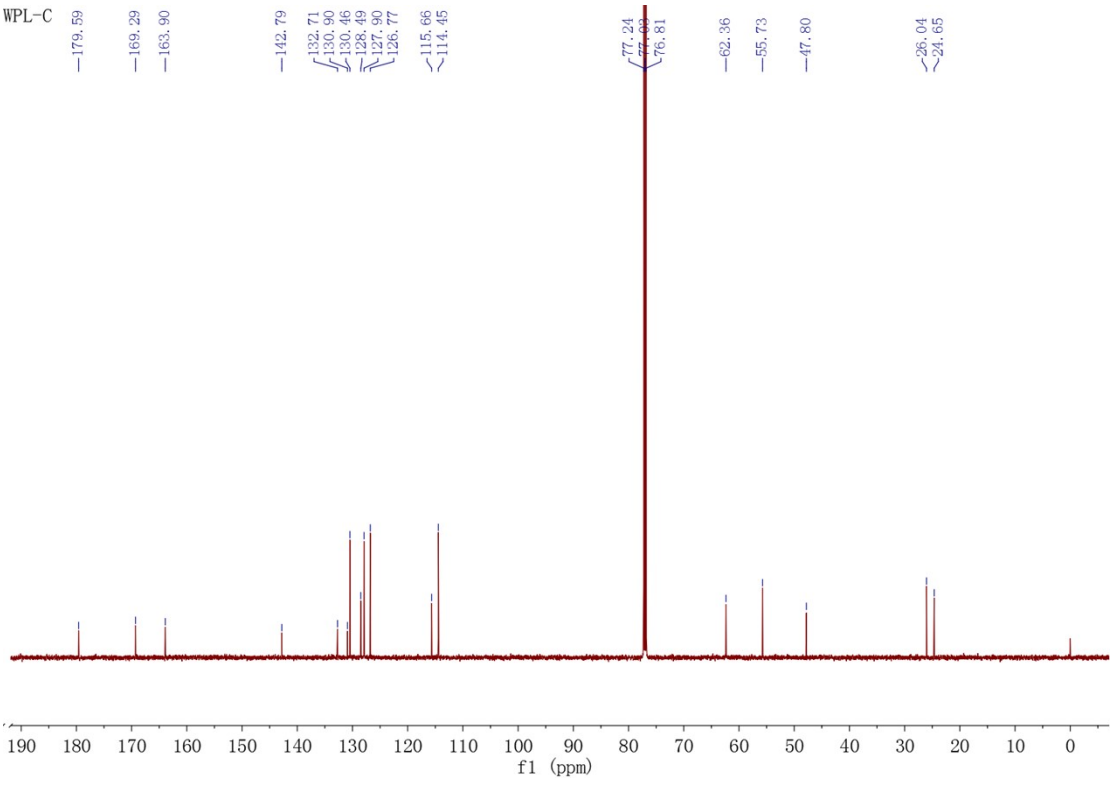

WPL-H
7.68
7.67
7.37
7.36
7.36
7.26
7.24
7.23
7.22
5.49
3.72
3.70
3.47
3.44
2.49
2.49
1.58
1.39
2.04
3.21
4.08
1.05
1.10
1.07
3.21
2.71
3.00
f1 (ppm)

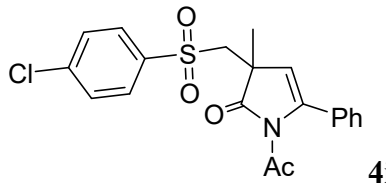

WPL-C
179.50
169.31
147.81
142.88
132.65
128.54
128.49
127.93
126.75
125.29
115.56
77.25
77.04
76.83
62.24
47.78
26.01
24.69
14.65
f1 (ppm)


MeO
O
S
O
O
N
Ac
Ph

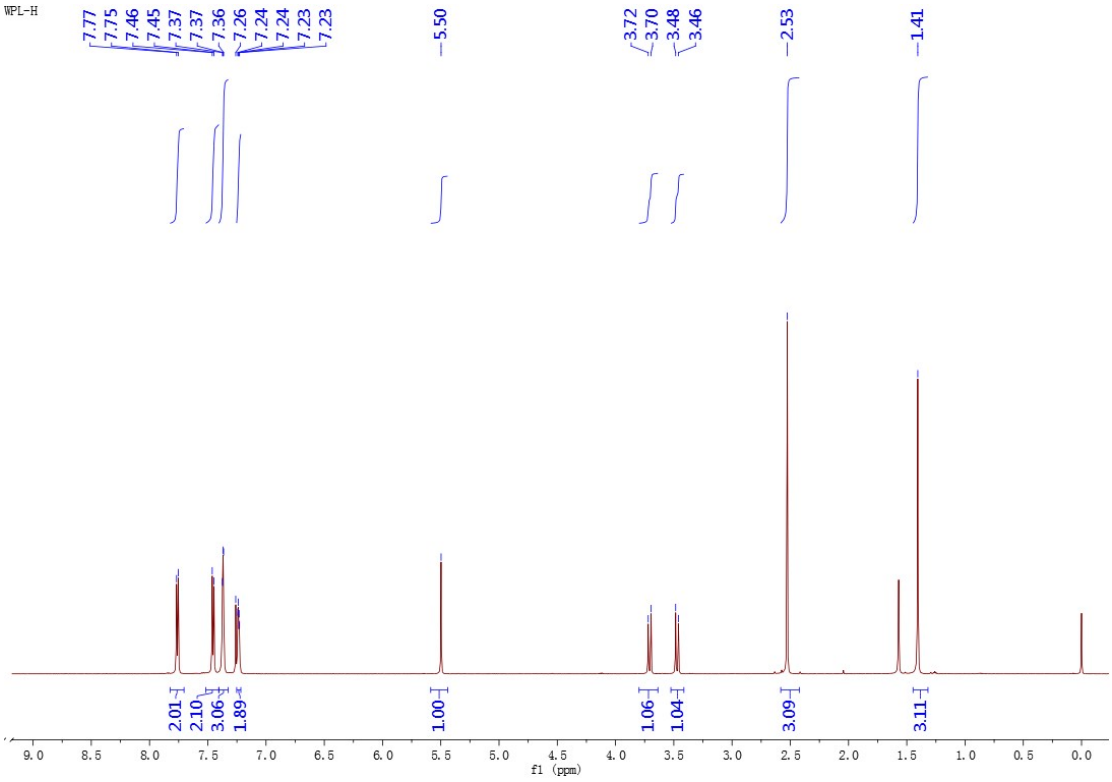
4h

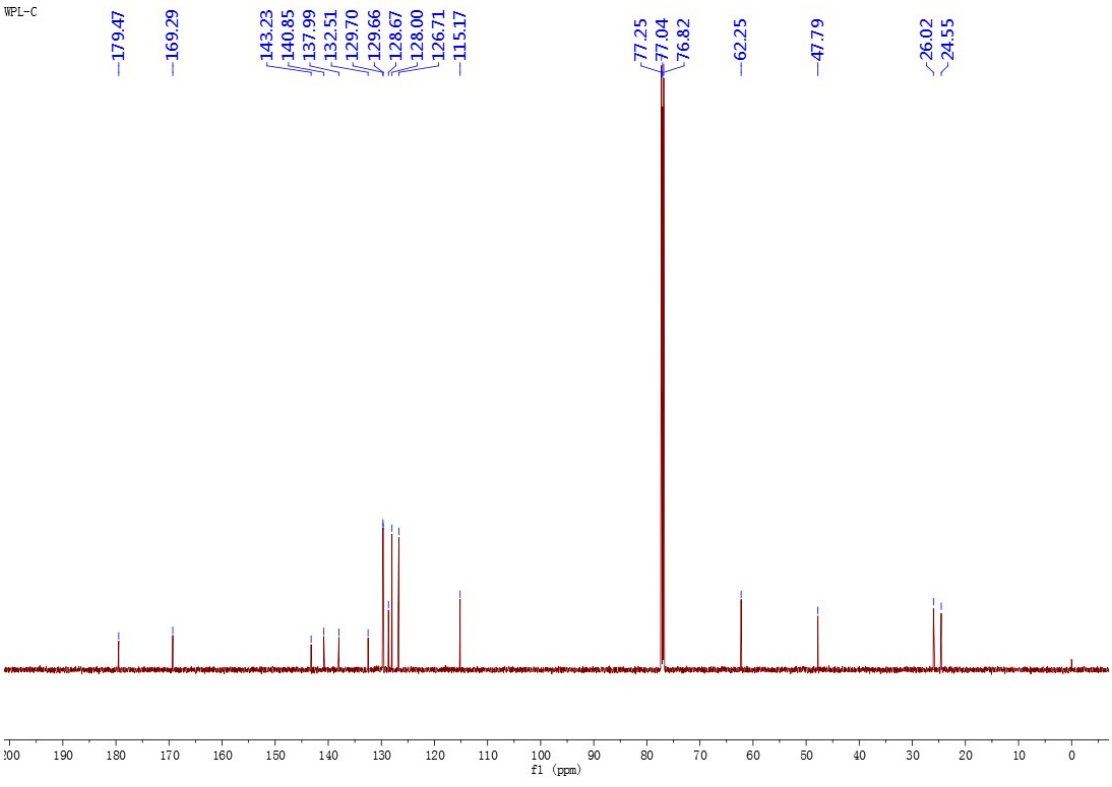

WPL-H
7.75
7.73
7.36
7.36
7.35
6.92
6.90
5.50
3.84
3.71
3.69
3.46
3.44
2.50
1.39
2.03
3.13
1.85
2.02
1.00
1.04
1.02
3.06
3.10
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

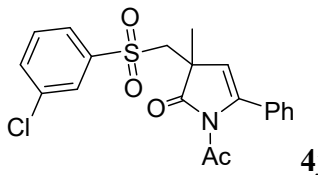

WPL-C
179.59
169.29
163.90
142.79
132.71
130.90
130.46
128.49
127.90
126.77
115.66
114.45
77.24
77.03
76.81
62.36
55.73
47.80
26.04
24.65
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


Cl
S
O
O
O
N
Ac
Ph

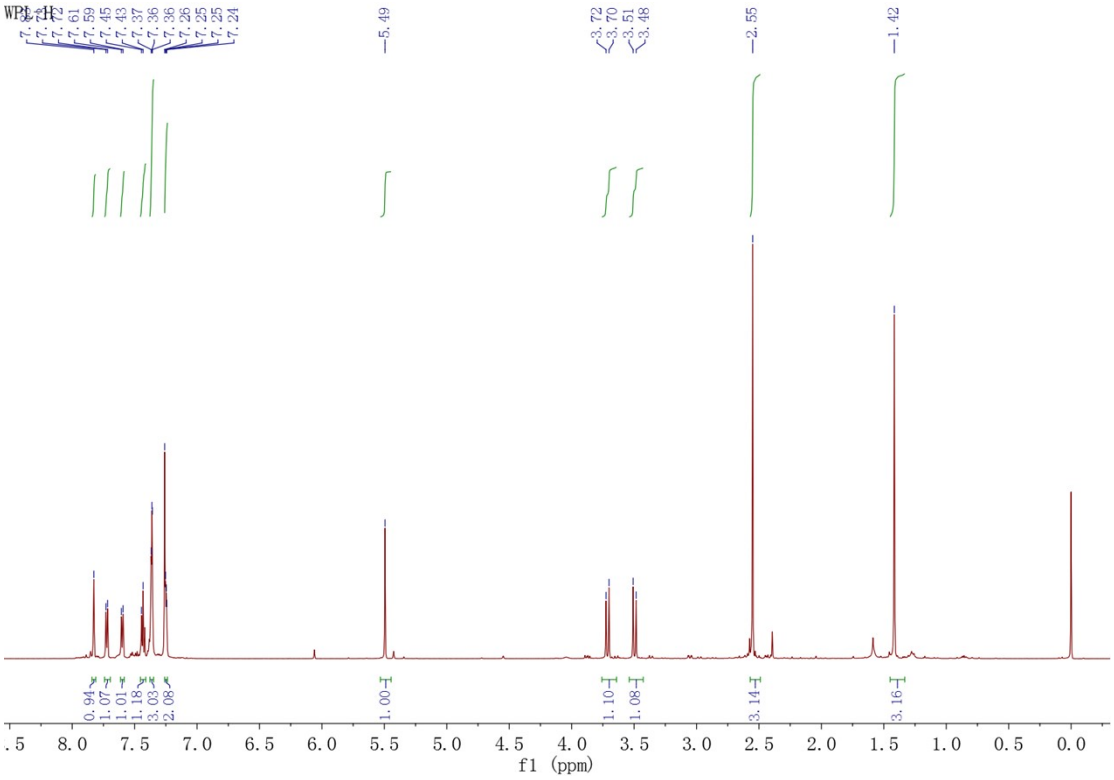
4i

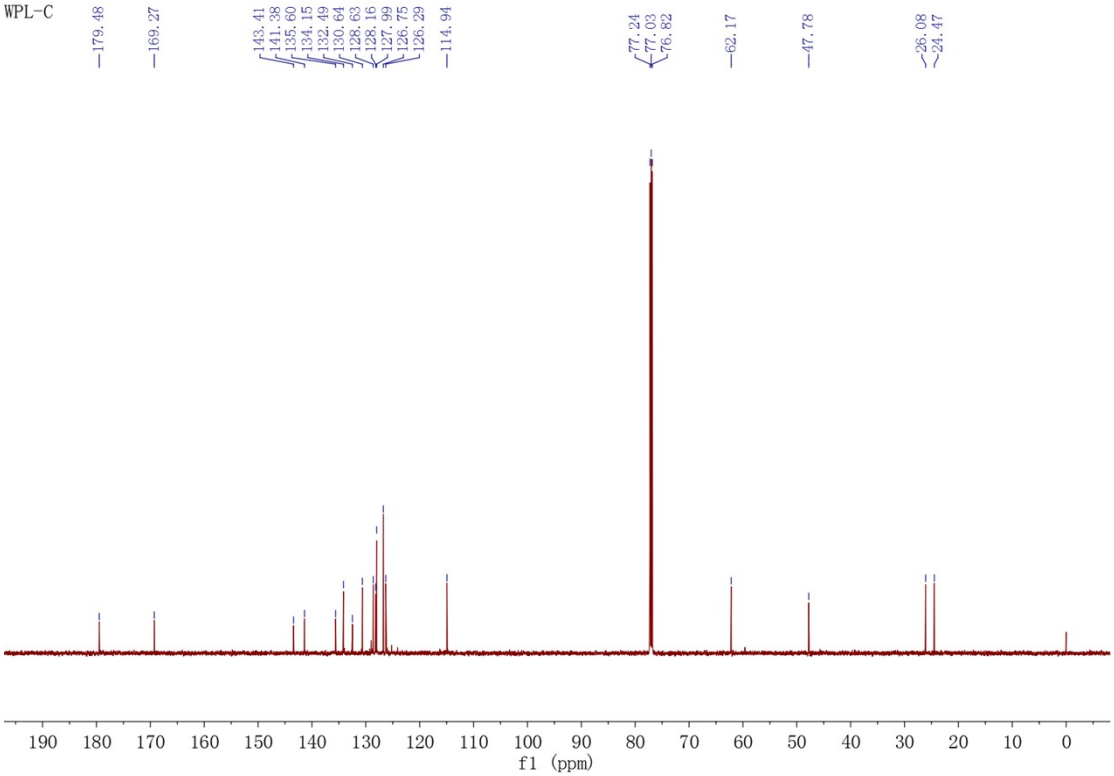

WPL-H
7.77
7.75
7.46
7.45
7.37
7.37
7.36
7.26
7.24
7.24
7.23
7.23
5.50
3.72
3.70
3.48
3.46
2.53
1.41
2.01
2.10
3.06
1.89
1.00
1.06
1.04
3.09
3.11
f1 (ppm)

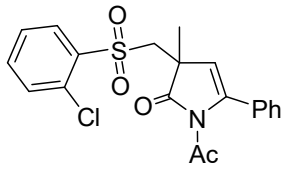

WPL-C
179.47
169.29
143.23
140.85
137.99
132.51
129.70
129.66
128.67
128.00
126.71
115.17
77.25
77.04
76.82
62.25
47.79
26.02
24.55
f1 (ppm)


O
S
O
O
N
Ac
Ph
Cl

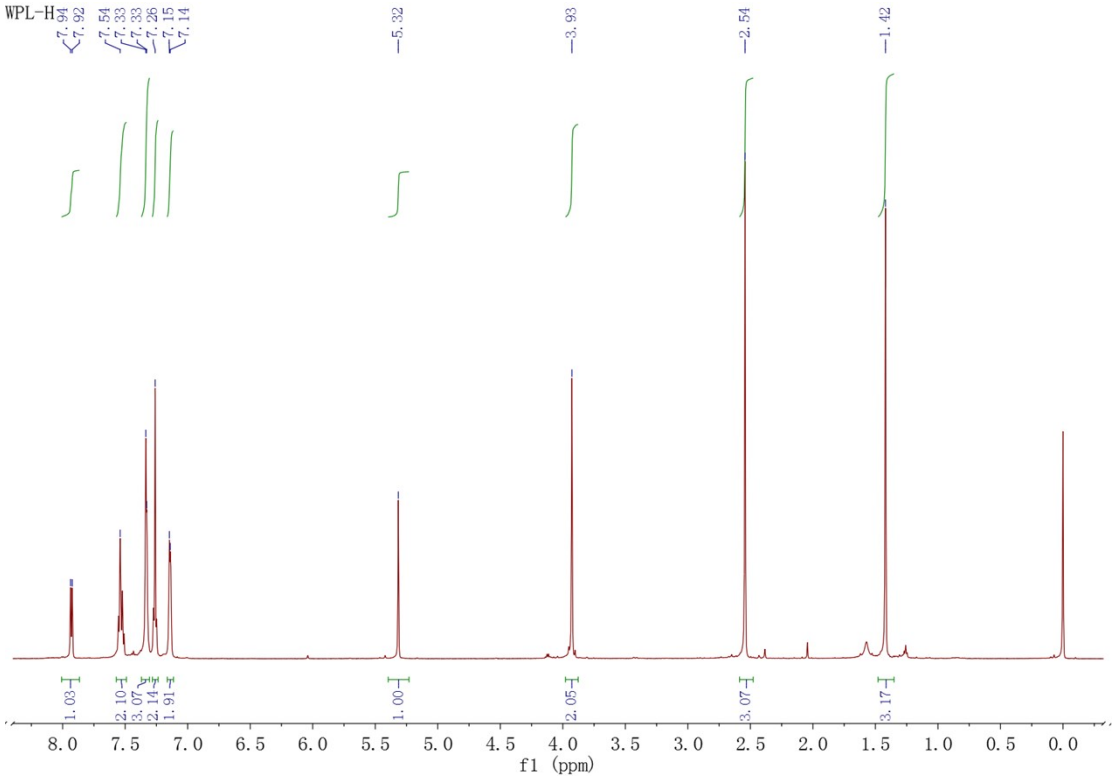
4j

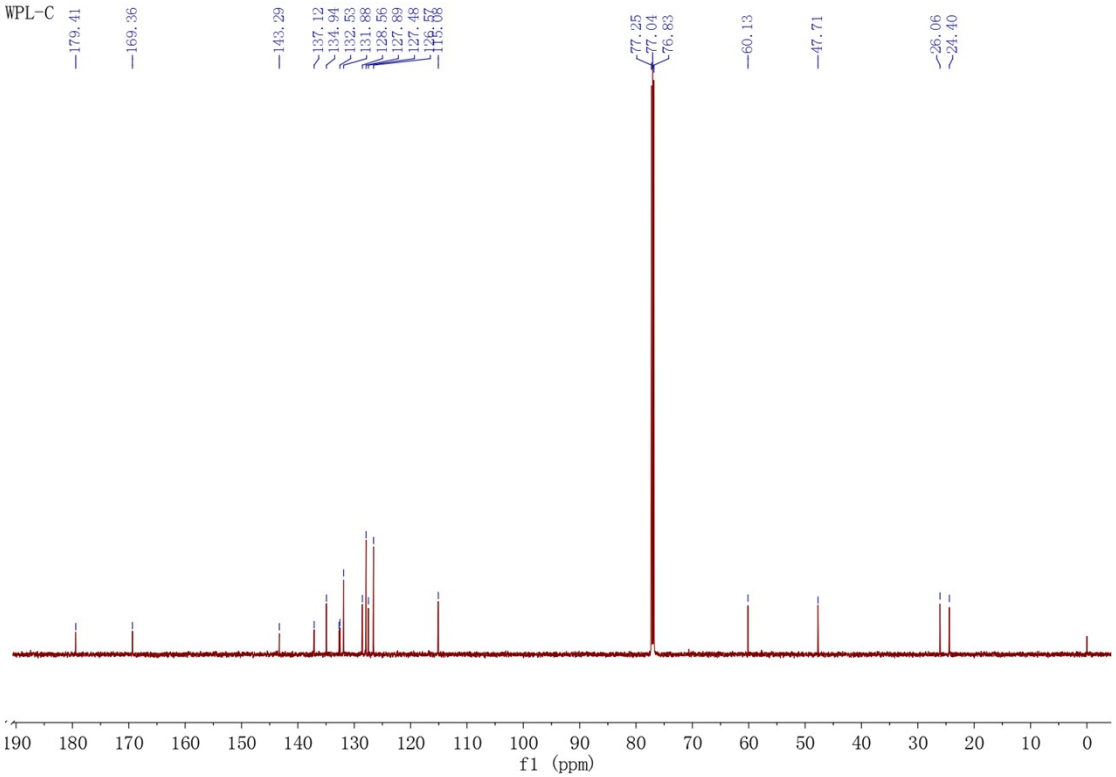

WPL-H
7.74
7.72
7.61
7.59
7.45
7.43
7.37
7.36
7.36
7.26
7.25
7.25
7.24
5.49
3.72
3.70
3.51
3.48
2.55
1.42
0.94
1.07
1.01
1.18
3.03
2.08
1.00
1.10
1.08
3.14
3.16
f1 (ppm)

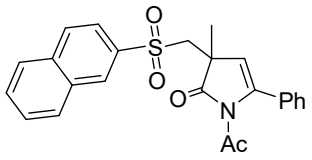

WPL-C
179.48
169.27
143.41
141.38
135.60
134.15
132.49
130.64
128.63
128.16
127.99
126.75
126.29
114.94
77.24
77.03
76.82
62.17
47.78
26.08
24.47
f1 (ppm)


O
S
O
Cl
O
N
Ac
Ph

4k

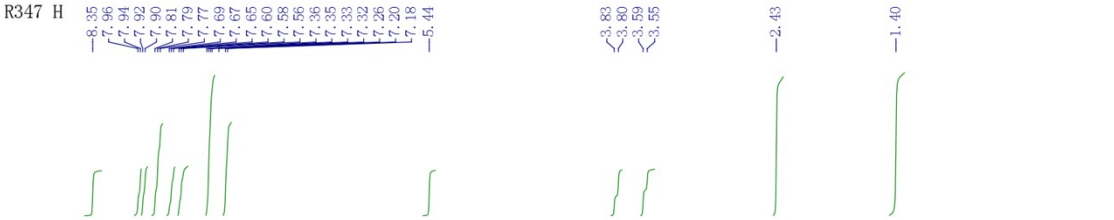

WPL-H
7.94
7.92
7.54
7.33
7.26
7.15
7.14
5.32
3.93
2.54
1.42
1.03
2.10
3.07
2.14
1.91
1.00
2.05
3.07
3.17
8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

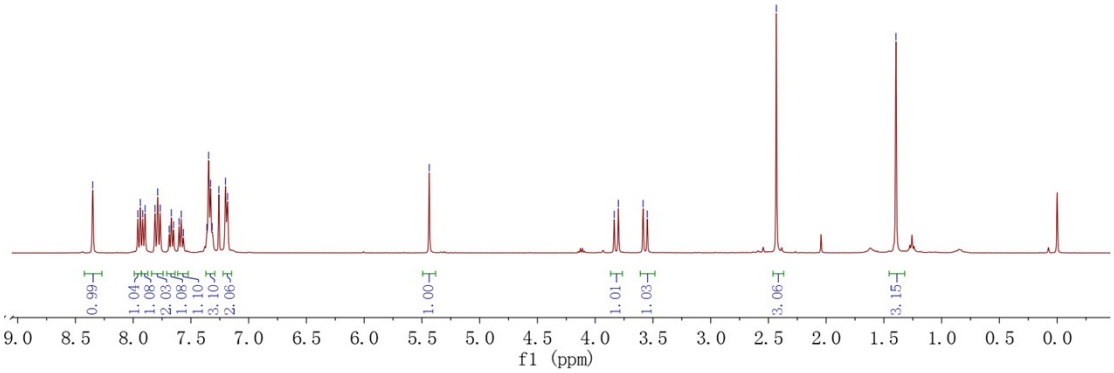

WPL-C
179.41
169.36
143.29
137.12
134.94
132.53
131.88
128.56
127.89
127.48
126.57
115.08
77.25
77.04
76.83
60.13
47.71
26.06
24.40
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)



4l

R347 H





R347 C