Electronic Supplementary Information

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I. General Information

All the solvents and commercially available reagents were purchased from commercial sources and used directly. Thin layer chromatography (TLC) was performed on EMD precoated plates (silica gel 60 F254, Art 5715) and visualized by fluorescence quenching under UV light. Column chromatography was performed on EMD Silica Gel 60 (200–300 Mesh) using a forced flow of 0.5–1.0 bar. The ^{1}H and ^{13}C NMR spectra were obtained on a Bruker AVANCE Ⅲ–400 or 300 spectrometer. ^{1}H NMR data were reported as: chemical shift (δ ppm), multiplicity, coupling constant (Hz), and integration. ^{13}C NMR data were reported in terms of chemical shift (δ ppm), multiplicity, and coupling constant (Hz). Infrared (IR) spectra were recorded on a Nicolet 6700 spectrophotometer and reported as wave number (cm^{-1}). Mass (MS) analysis was obtained using SHIMADZU-2020 LC/MS system with Electrospray Ionization (ESI).

II. Experimental Section

Synthesis of starting materials:

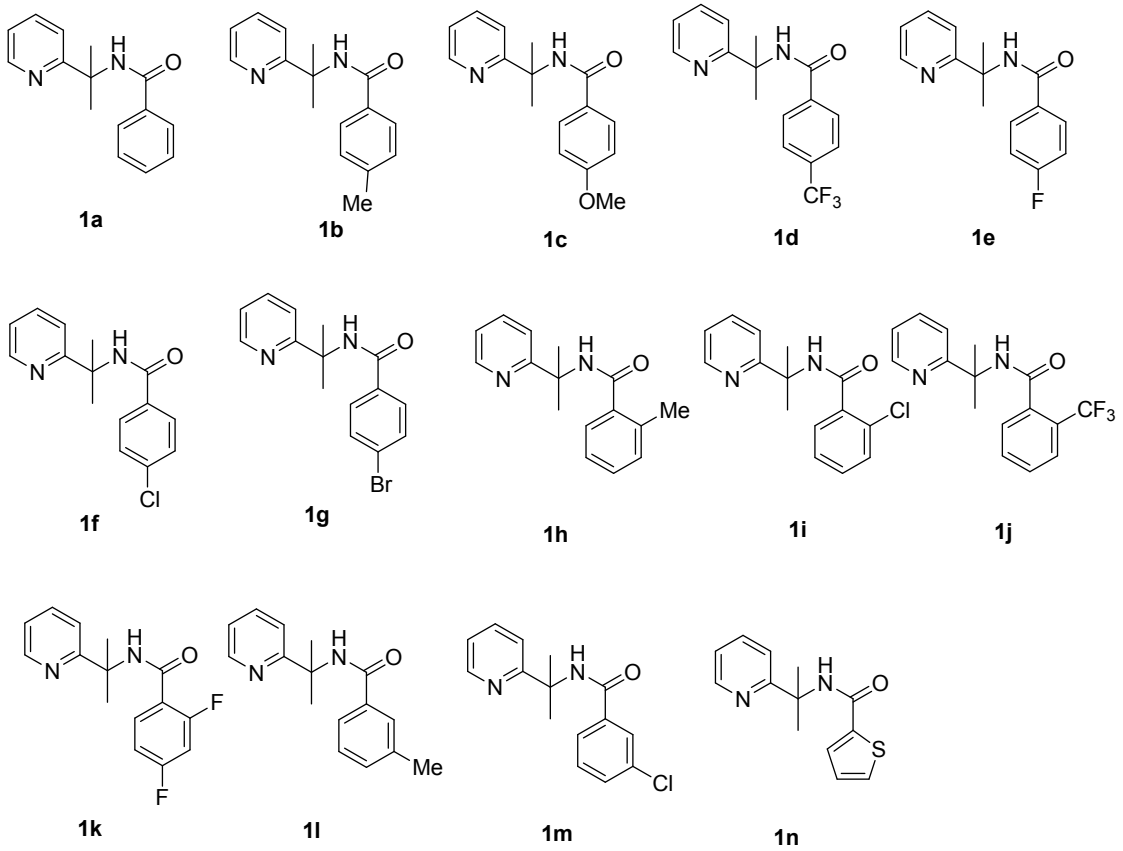


Figure 1 Benzamides (**1**)

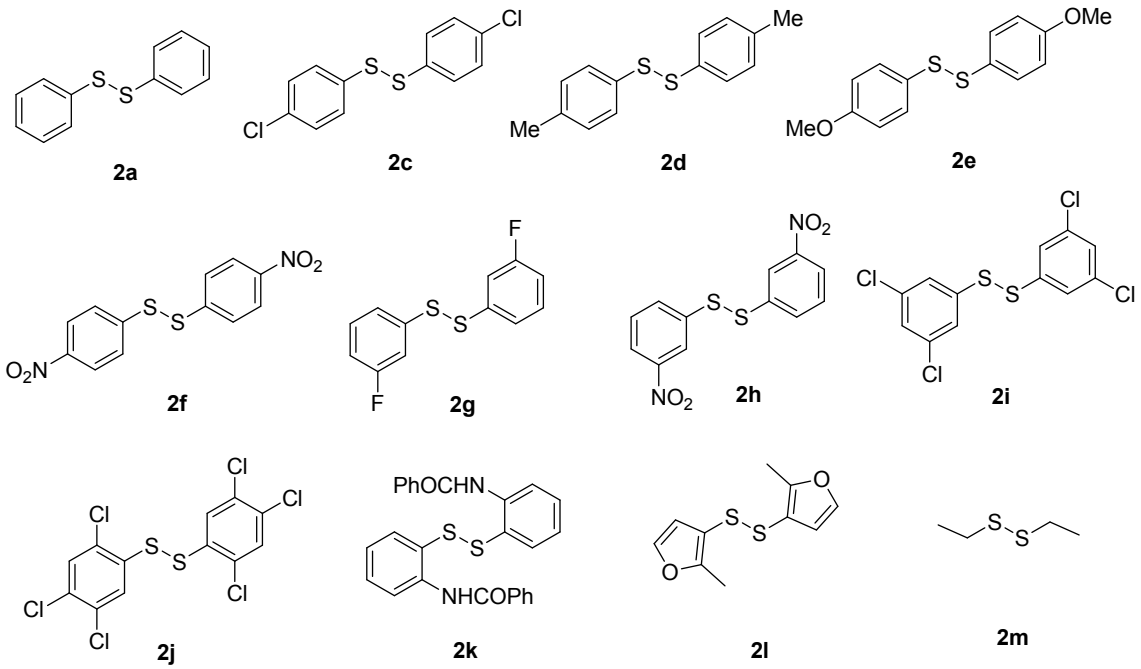


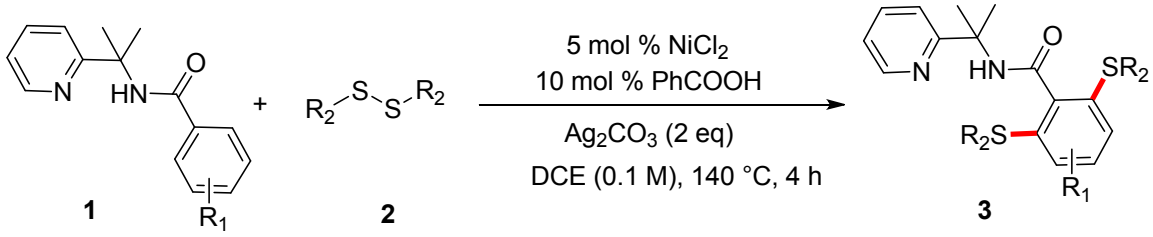
Figure 2 Disulfides (**2**)

Benzamides (**1**) were prepared from 2-(pyridine-2-yl)-isopropylamine and the corresponding benzaldehydes according to the reported procedure.[1-3] Disulfides (**2**) were all purchased from Adamas-beta, TCI or J&K@.

Optimization of the reaction conditions

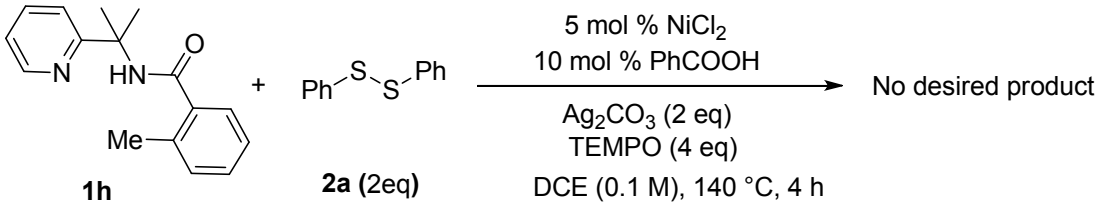
A 35 mL oven-dried pressure tube was charged with benzamides **1a** (0.2 mmol), diphenyl disulfide (0.6 mmol), Ni source (0.005 - 0.01 mmol), ligand (0.02 mmol), additives (0.2 - 0.4 mmol), and solvent (2.0 mL). The tube was then sealed and stirred vigorously at 120-140 ˚C for 4-10 h. After cooling to room temperature, the reaction mixture was diluted with EtOAc (15 mL), filtered through a pad of celite The filtrate was concentrated in *vacuo*, and the crude product was analyzed by ^{1}H NMR in $CDCl_3$. Yields and conversions are based on **1a**, determined by crude ^{1}H NMR using dibromomethane as the internal standard. And the residue was purified by flash chromatography on silica gel (gradient eluent of 10% EtOAc in hexanes, *v*/*v*) to yield the product **3a**.

General procedure for the scope study



A 35 mL oven-dried pressure tube was charged with benzamides (**1**, 0.2 mmol), disulfide (**2**, 0.4 mmol), $NiCl_2$ (1.3 mg, 0.01 mmol), PhCOOH (2.4 mg, 0.02 mmol), Ag_2CO_3 (110.3 mg, 0.4 mmol), and DCE (2.0 mL). The tube was then sealed and stirred vigorously at 140 ˚C for 4 h. After cooling to room temperature, the reaction mixture was diluted with EtOAc (15 mL), filtered through a pad of Celite, and then the filtrate was concentrated in *vacuo*. The residue was purified by flash chromatography on silica gel (gradient eluent of 10% EtOAc in hexanes, *v*/*v*) to give the desired product **3**.

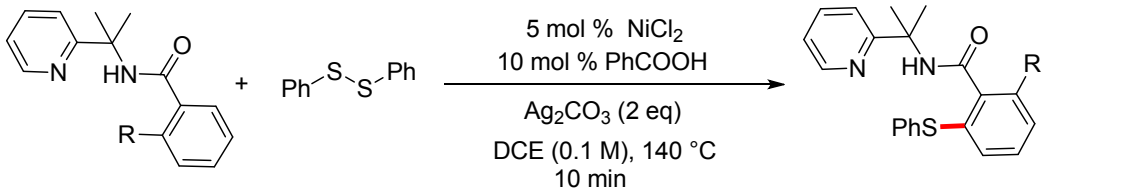
Radical Trapping Experiment



Scheme S1

A 35 mL oven-dried pressure tube was charged with benzamides **1h** (0.2 mmol), diphenyl disulfide **2a** (0.4 mmol), TEMPO (0.8 mmol), $NiCl_2$ (1.3 mg, 0.01 mmol), PhCOOH (2.4 mg, 0.02 mmol), Ag_2CO_3 (110.3 mg, 0.4 mmol), and DCE (2.0 mL). The tube was then sealed and stirred vigorously at 140 ˚C for 4 h. After cooling to room temperature, the reaction mixture was diluted with EtOAc (15 mL), filtered through a pad of Celite, and then the filtrate was concentrated in *vacuo*, and the crude product was analyzed by ^1H NMR in $CDCl_3$, no desired product **3h** was found in the ^1H NMR.

Intermolecular Competition Experiment



1h, R = Me
1j, R = CF_3

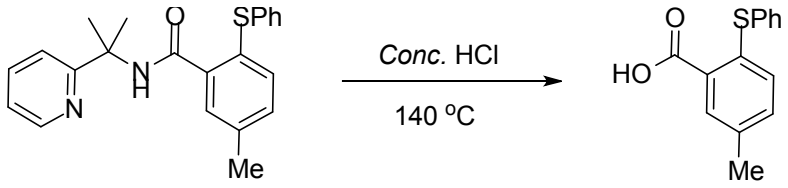
2a

3h, R = Me, 17% (^{1}H NMR)
3j, R = CF_3, 5% (^{19}F NMR)

Scheme S2

A 35 mL oven-dried pressure tube was charged with benzamides **1h** (0.2 mmol), benzamides **1j** (0.2 mmol), diphenyl disulfide **2a** (0.4 mmol), $NiCl_2$ (1.3 mg, 0.01 mmol), PhCOOH (2.4 mg, 0.02 mmol), Ag_2CO_3 (110.3 mg, 0.4 mmol), and DCE (2.0 mL). The tube was then sealed and stirred vigorously at 140 ˚C for 10 min. After cooling to room temperature, the reaction mixture was diluted with EtOAc (15 mL), filtered through a pad of Celite, and then the filtrate was concentrated in *vacuo*, yields are determined by crude ^{1}H NMR and ^{19}F NMR using CH_2Br_2 and $PhCF_3$ as the internal standard..

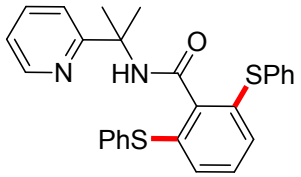
Removal of Directing Group



3l **4l**

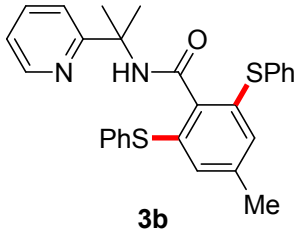
To a 35 mL Schlenk tube was added **3l** (0.1 mmol) and conc. HCl (2 mL). The mixture was then heated at 140 °C for 72 hours. The reaction mixture was cooled to room temperature, aqueous NaOH (1 M) was added and the aqueous phase was extracted with DCM (10 mL). Then, conc. HCl was added slowly into the aqueous phase (pH = 2) and the aqueous phase was as extracted with DCM (10 mL × 3). The combined organic phase was dried with anhydrous magnesium sulfate. After concentration, the desired product **4l** was obtained. White solid, yield 81%.[4] ^{1}H NMR (400 MHz, $CDCl_3$) δ 10.47 (s, 1H), 7.97 (s, 1H), 7.58 (d, J = 4.4 Hz, 2H), 7.45 (d, J = 3.6 Hz, 3H), 7.14 (d, J = 7.2 Hz, 1H), 6.77 (d, J = 8.0 Hz, 1H), 2.35 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 171.80, 140.67, 135.46, 134.40, 134.22, 132.73, 132.49, 129.74, 129.04, 127.75, 125.55, 20.56.

Data of new products



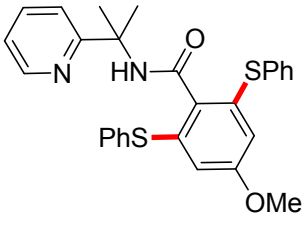
3a

White solid, m.p.: 130-131 °C, yield: 92%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.37 (d, J = 4.4 Hz, 1H), 8.09 (s, 1H), 7.67 (td, J = 8.0, 1.6 Hz, 1H), 7.46 (d, J = 8.0 Hz, 1H), 7.42 – 7.36 (m, 4H), 7.30 – 7.17 (m, 7H), 7.15 – 7.05 (m, 4H), 1.87 (s, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 165.60, 163.98, 147.18, 141.22, 137.07, 135.12, 134.67, 131.76, 130.57, 129.56, 129.24, 127.40, 121.72, 119.53, 57.56, 27.27. IR (neat) v 3318, 2979, 1669, 1498, 1471, 1428, 998, 885, 750, 693, 591 cm^{-1}. HRMS (ESI, *m/z*): calcd. for $C_{27}H_{25}N_2OS_2$ $(M+H)^+$: 457.1408, found: 457.1410.



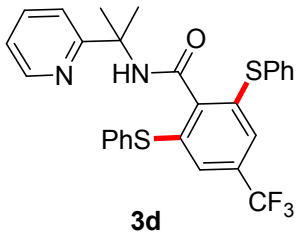
3b

White solid, m.p.: 108-110 °C, yield: 81%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.40 – 8.32 (m, 1H), 7.94 (s, 1H), 7.66 (td, J = 8.0, 1.6 Hz, 1H), 7.46 (d, J = 8.0 Hz, 1H), 7.38 (dd, J = 5.2, 3.2 Hz, 4H), 7.29 – 7.24 (m, 4H), 7.22 – 7.17 (m, 2H), 7.12 (m, 1H), 6.97 (s, 2H), 2.16 (s, 3H), 1.83 (s, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 165.84, 164.17, 147.29, 139.85, 139.75, 136.98, 135.77, 133.89, 132.18, 131.28, 129.22, 127.14, 121.67, 119.56, 57.60, 27.31, 21.14. IR (neat) v 3385, 2981, 1650, 1535, 1475, 1435, 1300, 1026, 790, 740, 689 cm^{-1}. HRMS (ESI, *m/z*): calcd. for $C_{28}H_{27}N_2OS_2$ $(M+H)^+$: 471.1565, found: 471.1565.



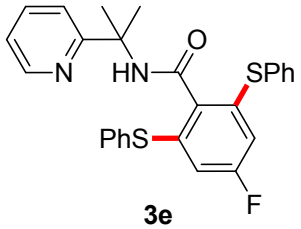
3c

Colorless oil, yield: 83%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.40 (d, J = 4.4 Hz, 1H), 7.98 (s, 1H), 7.69 – 7.65 (m, 1H), 7.47 (d, J = 8.0 Hz, 1H), 7.42 (d, J = 7.2 Hz, 4H), 7.32 – 7.21 (m, 6H), 7.18 – 7.10 (m, 1H), 6.57 (s, 2H), 3.55 (s, 3H), 1.85 (s, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 165.66, 164.24, 159.77, 147.35, 136.99, 136.24, 134.83, 133.87, 132.10, 129.33, 127.62, 121.69, 119.59, 115.58, 57.61, 55.28, 27.34. IR (neat) ν 3312, 2965, 1653, 1578, 1544, 1472, 1423, 1295, 1240, 1063, 1023, 911, 742, 689 cm^{-1}. HRMS (ESI, *m/z*): calcd. for $C_{28}H_{27}N_2O_2S_2$ $(M+H)^+$: 487.1514, found: 487.1514.



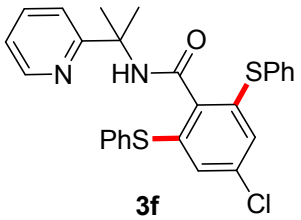
3d

White solid, m.p.: 128-129 °C, yield: 90%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.48 – 8.35 (m, 2H), 7.70 (td, J = 8.0, 1.6 Hz, 1H), 7.54 – 7.39 (m, 5H), 7.36 – 7.24 (m, 6H), 7.16 (m, 3H), 1.93 (s, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 164.55, 163.84, 147.26, 142.17, 137.25, 133.16, 132.89, 131.69 (q, $J_{C,F}$ = 33.0 Hz), 129.64, 128.46, 125.29 (q, $J_{C,F}$ = 3.5 Hz), 123.08 (q, $J_{C,F}$ = 272.0 Hz), 121.93, 119.51, 57.72, 27.30. IR (neat) ν 3283, 2977, 1647, 1539, 1475, 1293, 1128, 1109, 746, 687 cm^{-1}. HRMS (ESI, *m/z*): calcd. for $C_{28}H_{24}F_3N_2OS_2$ $(M+H)^+$: 525.1282, found: 525.1281.



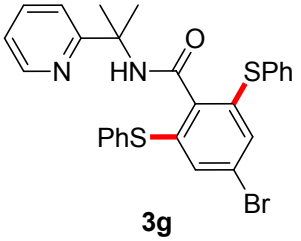
3e

Yellow oil, yield: 90%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.45 (d, J = 4.8 Hz, 1H), 8.33 (s, 1H), 7.74 – 7.67 (m, 1H), 7.51 – 7.45 (m, 5H), 7.38 – 7.27 (m, 6H), 7.19 – 7.15 (m, 1H), 6.55 (d, J = 9.2 Hz, 2H), 1.93 (s, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 164.99, 164.06, 162.47 (d, $J_{C,F}$ = 250.0 Hz), 147.35, 138.60 (d, $J_{C,F}$ = 9.0 Hz), 137.21, 134.58 (d, $J_{C,F}$ = 3.0 Hz), 133.49, 133.09, 129.65, 128.57, 121.91, 119.62, 114.71 (d, $J_{C,F}$ = 24.0 Hz), 57.67, 27.38. IR (neat) ν 3320, 2984, 1661, 1564, 1550, 1471, 1428, 748, 691 cm^{-1}. HRMS (ESI, *m/z*): calcd. for $C_{27}H_{24}FN_2OS_2$ $(M+H)^+$: 475.1314, found: 475.1313.



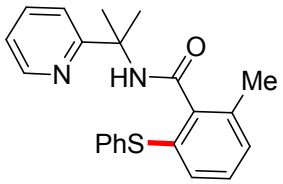
3f

Yellow oil, yield: 95%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.45 – 8.39 (m, 1H), 8.32 (s, 1H), 7.70 (td, J = 8.0, 1.6 Hz, 1H), 7.49 – 7.42 (m, 5H), 7.35 – 7.26 (m, 6H), 7.17 (m, 1H), 6.88 (s, 2H), 1.91 (s, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 164.87, 163.99, 147.31, 137.66, 137.54, 137.21, 135.22, 133.40, 133.02, 129.61, 128.37, 128.22, 121.90, 119.58, 57.66, 27.34. IR (neat) v 3299, 2971, 1653, 1559, 1535, 1472, 1439, 1127, 887, 786, 743, 688 cm^{-1}. HRMS (ESI, *m/z*): calcd. for $C_{27}H_{24}ClN_2OS_2$ $(M+H)^+$: 491.1019, found: 491.1019.



3g

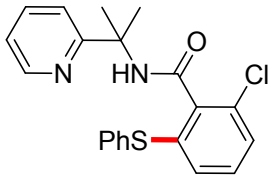
White solid, m.p.: 117-119 ^{o}C, yield: 89%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.42 (m, 1H), 8.33 (s, 1H), 7.70 (td, J = 8.0, 1.6 Hz, 1H), 7.50 – 7.42 (m, 5H), 7.37 – 7.25 (m, 6H), 7.16 (m, 1H), 7.06 (s, 2H), 1.90 (s, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 164.88, 163.96, 147.29, 138.36, 137.58, 137.23, 133.51, 132.88, 131.24, 129.62, 128.34, 123.29, 121.92, 119.58, 57.65, 27.34. IR (neat) v 3280, 2981, 1647, 1559, 1475, 1435, 1300, 1026, 790, 740 689 cm^{-1}. HRMS (ESI, *m/z*): calcd. for $C_{27}H_{24}BrN_2OS_2$ $(M+H)^+$: 537.0493, found: 537.0493.



3h

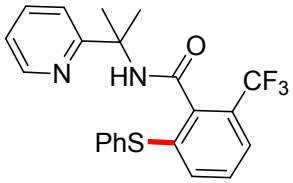
White solid, m.p.: 80-81 ^{o}C, yield: 92%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.45 – 8.30 (m, 1H), 7.92 (s, 1H), 7.68 (td, J = 8.0, 2.0 Hz, 1H), 7.44 (d, J = 8.0 Hz, 1H), 7.31 – 7.09 (m, 9H), 2.41 (s, 3H), 1.86 (s, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 167.36, 164.18, 147.42, 141.32, 137.05, 136.80,

136.11, 131.61, 130.93, 130.32, 129.73, 129.09, 126.60, 121.79, 119.49, 57.30, 27.35, 19.36. IR (neat) *v* 3280, 2980, 1662, 1506, 1470, 1438, 1047, 997, 886, 786, 765, 690 cm^{-1}. HRMS (ESI, *m/z*): calcd. for $C_{22}H_{23}N_2OS$ $(M+H)^+$: 363.1531, found: 363.1531.



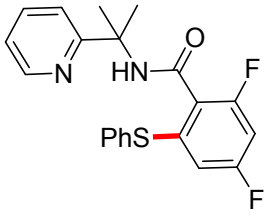
3i

Yellow oil, yield: 82%. ^1H NMR (400 MHz, $CDCl_3$) δ 8.46 – 8.38 (m, 1H), 8.16 (s, 1H), 7.72 (td, J = 8.0, 1.6 Hz, 1H), 7.49 (d, J = 8.0 Hz, 1H), 7.41 – 7.36 (m, 2H), 7.31 – 7.25 (m, 3H), 7.24 – 7.14 (m, 3H), 7.08 (dd, J = 8.0, 1.2 Hz, 1H), 1.91 (s, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 164.47, 163.90, 147.23, 138.78, 137.27, 136.04, 134.66, 132.05, 131.72, 130.11, 129.86, 129.35, 128.06, 127.68, 121.90, 119.59, 57.55, 27.30. IR (neat) *v* 3299, 2982, 1653, 1506, 1472, 1429, 1195, 886, 785, 747, 690 cm^{-1}. HRMS (ESI, *m/z*): calcd. for $C_{21}H_{20}ClN_2OS$ $(M+H)^+$: 383.0985, found: 383.0986.



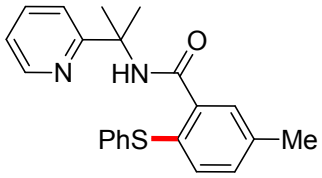
3j

White solid, m.p.: 127-129 °C, yield: 93%. ^1H NMR (400 MHz, $CDCl_3$) δ 8.47 (s, 1H), 8.43 (d, J = 4.4 Hz, 1H), 7.75 (t, J = 7.6 Hz, 1H), 7.57 – 7.55 (m, 1H), 7.50 – 7.44 (m, 3H), 7.36 – 7.27 (m, 5H), 7.22 – 7.19 (m, 1H), 1.94 (s, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 164.37, 163.85, 147.09, 137.38, 137.07, 134.85, 134.20, 132.68, 129.48, 129.14, 128.02 (q, $J_{C,F}$ = 32.0 Hz), 128.03, 124.46 (q, $J_{C,F}$ = 4.8 Hz), 123.59 (q, $J_{C,F}$ = 273.0 Hz), 121.97, 119.60, 57.51, 26.98. IR (neat) *v* 3308, 2982, 2924, 1670, 1504, 1474, 1430, 1312, 1171, 1158, 1071, 887, 790, 749, 691 cm^{-1}. HRMS (ESI, *m/z*): calcd. for $C_{22}H_{20}F_3N_2OS$ $(M+H)^+$: 417.1248, found: 417.1248.



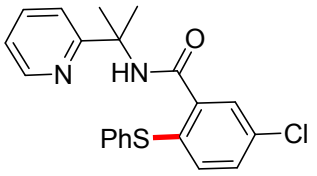
3k

Colorless oil, yield: 91%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.49 (dd, J = 4.8, 0.8 Hz, 1H), 8.45 (s, 1H), 7.73 (td, J = 8.0, 1.6 Hz, 1H), 7.55 – 7.46 (m, 3H), 7.43 – 7.35 (m, 3H), 7.21 – 7.18 (m, 1H), 6.63 (td, J = 9.2, 2.4 Hz, 1H), 7.44 – 7.41 (m, 1H), 1.91 (s, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 163.94, 162.71 (dd, J = 252.0, 13.0 Hz), 161.90, 159.98 (dd, J = 250.0, 13.0 Hz), 147.48, 142.29 (dd, J = 10.0, 6.0 Hz), 137.26, 134.55, 131.99, 129.83, 129.19, 121.99, 121.30 (dd, J = 20.0, 4.0 Hz), 119.53, 111.41 (dd, J = 24.0, 3.0 Hz), 101.36 (t, J = 26.0 Hz), 57.65, 27.50. IR (neat) v 3296, 2980, 1653, 1606, 1440, 1415, 1104, 995, 848, 747 691 cm^{-1}. HRMS (ESI, *m/z*): calcd. for $C_{21}H_{19}F_2N_2OS$ $(M+H)^+$: 385.1186, found: 385.1188.



3l

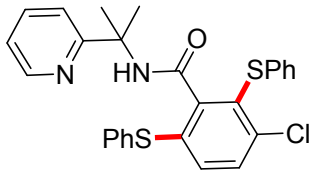
White solid, m.p.: 118-120 ^{o}C, yield: 92%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.34 (d, J = 4.0 Hz, 1H), 8.27 (s, 1H), 7.57 (dd, J = 12.0, 4.0 Hz, 1H), 7.44 (s, 1H), 7.29 (d, J = 8.0 Hz, 1H), 7.20 – 7.00 (m, 8H), 2.27 (s, 3H), 1.68 (s, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 166.00, 163.31, 146.59, 138.12, 136.84, 135.91, 135.49, 132.57, 130.20, 129.06, 128.67, 128.15, 128.03, 125.64, 120.67, 118.36, 56.32, 26.37, 19.94. IR (neat) v 3269, 2980, 1637, 1533, 1549, 1320, 1211, 818, 747, 694, 683 cm^{-1}. HRMS (ESI, *m/z*): calcd. for $C_{22}H_{23}N_2OS$ $(M+H)^+$: 363.1531, found: 363.1531.



3ma

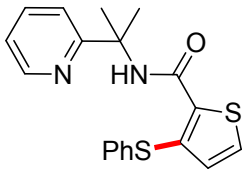
Colorless oil, yield: 47%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.52 (s, 1H), 8.47 (d, J = 4.8 Hz, 1H), 7.73 (td, J = 8.0, 1.6 Hz, 1H), 7.64 (d, J = 2.4 Hz, 1H), 7.43 (d, J = 8.0 Hz, 1H), 7.39 – 7.26 (m,

5H), 7.25 – 7.17 (m, 2H), 7.08 (d, J = 8.4 Hz, 1H), 1.83 (s, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 165.73, 164.01, 147.45, 139.20, 137.35, 134.58, 133.50, 132.85, 132.70, 132.08, 130.32, 129.49, 128.54, 127.80, 121.99, 119.52, 57.37, 27.36. IR (neat) v 3296, 2977, 1653, 1506, 1473, 1439, 1306, 1098, 1048, 786, 746, 691 cm^{-1}. HRMS (ESI, m/z): calcd. for $C_{21}H_{20}ClN_2OS$ $(M+H)^+$: 383.0985, found: 383.0985.



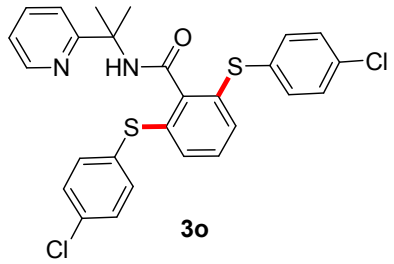
3mb

Colorless oil, yield: 30%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.32 (d, J = 4.4 Hz, 1H), 8.07 (s, 1H), 7.66 (td, J = 8.0, 1.6 Hz, 1H), 7.44 – 7.39 (m, 3H), 7.36 (d, J = 8.4 Hz, 1H), 7.32 – 7.25 (m, 3H), 7.23 – 7.05 (m, 7H), 1.84 (s, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 165.00, 163.91, 147.17, 147.04, 139.82, 137.04, 136.24, 134.46, 133.91, 133.83, 132.25, 130.88, 129.67, 129.45, 128.93, 128.19, 127.88, 126.01, 121.72, 119.43, 57.65, 27.19. IR (neat) v 3299, 2923, 1662, 1501, 1472, 1293, 1023, 787, 737, 688 cm^{-1}. HRMS (ESI, m/z): calcd. for $C_{27}H_{24}ClN_2OS_2$ $(M+H)^+$: 491.1019, found: 491.1019.



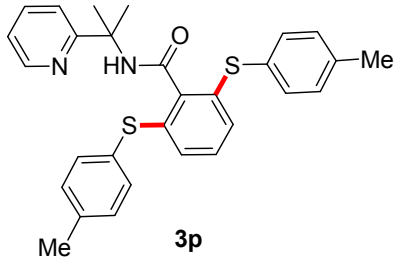
3n

White solid, m.p.: 64-66 ^{o}C, yield: 52%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.23 (s, 1H), 8.47 (d, J = 4.8 Hz, 1H), 7.64 (td, J = 7.6, 1.6 Hz, 1H), 7.41 (d, J = 5.2 Hz, 1H), 7.34 – 7.20 (m, 6H), 7.14 (dd, J = 7.2, 4.8 Hz, 1H), 6.95 (d, J = 5.2 Hz, 1H), 1.77 (s, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 164.30, 160.41, 147.91, 140.47, 136.89, 135.47, 133.62, 129.31, 129.19, 128.77, 128.55, 127.04, 121.76, 119.30, 57.87, 27.73. IR (neat) v 3218, 1993, 2964, 1627, 1569, 1501, 1477, 1431, 999, 731, 694, 626 cm^{-1}. HRMS (ESI, m/z): calcd. for $C_{19}H_{19}N_2OS_2$ $(M+H)^+$: 355.0939, found: 355.0939.



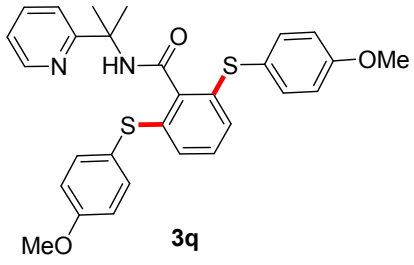
3o

White solid, m.p.: 147-148 °C, yield: 92%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.36 (d, J = 4.8 Hz, 1H), 8.17 (s, 1H), 7.72 (t, J = 7.6 Hz, 1H), 7.45 (d, J = 8.0 Hz, 1H), 7.33 – 7.27 (m, 4H), 7.25 – 7.12 (m, 8H), 1.88 (s, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 165.36, 163.73, 147.00, 142.25, 137.39, 134.05, 134.00, 133.44, 132.68, 131.68, 129.85, 129.40, 121.92, 119.55, 57.44, 27.19. IR (neat) v 3318, 2977, 1653, 1473, 1429, 1092, 1013, 824, 785, 750, 623 cm^{-1}. HRMS (ESI, *m/z*): calcd. for $C_{27}H_{23}Cl_2N_2OS_2$ $(M+H)^+$: 525.0629, found: 525.0629.



3p

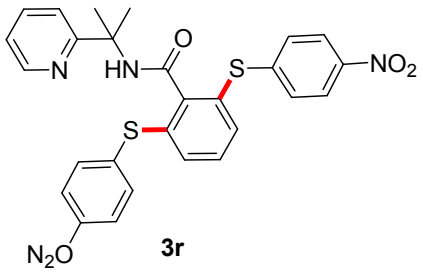
White solid, m.p.: 134-135 °C, yield: 93%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.42 (d, J = 4.4 Hz, 1H), 8.09 (s, 1H), 7.74 – 7.65 (m, 1H), 7.51 (d, J = 8.0 Hz, 1H), 7.33 (d, J = 8.0 Hz, 4H), 7.18 – 7.01 (m, 6H), 6.93 (d, J = 7.6 Hz, 2H), 2.30 (s, 6H), 1.91 (s, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 165.76, 164.09, 147.12, 139.50, 137.85, 137.22, 135.77, 132.81, 130.90, 130.10, 129.35, 128.87, 121.75, 119.69, 57.58, 27.35, 21.13. IR (neat) v 3317, 2974, 1656, 1490, 1471, 1427, 814, 784, 760 cm^{-1}. HRMS (ESI, *m/z*): calcd. for $C_{29}H_{29}N_2OS_2$ $(M+H)^+$: 485.1721, found: 485.1721.



3q

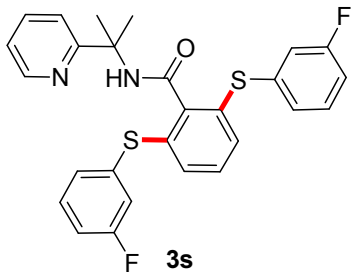
White solid, m.p.: 132-134 °C, yield: 95%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.46 (d, J = 4.4 Hz, 1H), 8.21 (s, 1H), 7.79 – 7.67 (m, 1H), 7.56 (d, J = 8.0 Hz, 1H), 7.43 (d, J = 8.8 Hz, 4H), 7.19 (dd,

J = 6.8, 5.2 Hz, 1H), 6.98 (t, J = 8.0 Hz, 1H), 6.86 (d, J = 8.8 Hz, 4H), 6.76 (d, J = 8.0 Hz, 2H), 3.77 (s, 6H), 1.97 (s, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 165.90, 164.14, 159.98, 147.18, 137.42, 137.30, 137.12, 135.77, 129.25, 126.84, 124.05, 121.94, 119.84, 115.05, 57.65, 55.37, 27.48. IR (neat) v 3342, 2971, 1654, 1588, 1502, 1426, 1249, 1171, 1023, 826, 775, 747 cm^{-1}. HRMS (ESI, m/z): calcd. for $C_{29}H_{29}N_2O_3S_2$ $(M+H)^+$: 517.1620, found: 517.1621.



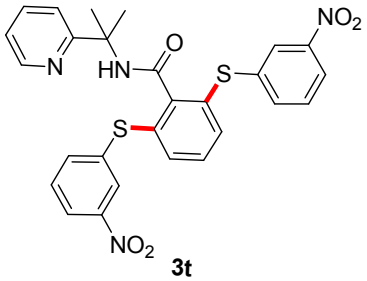
3r

Yellow solid, m.p.: 86-87 ^{o}C, yield: 78%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.10 (d, J = 4.4 Hz, 1H), 8.03 (s, 1H), 7.95 (d, J = 8.8 Hz, 4H), 7.61 – 7.58 (m, 3H), 7.46 (t, J = 7.6 Hz, 1H), 7.24 (d, J = 8.0 Hz, 1H), 7.15 (d, J = 8.8 Hz, 4H), 7.08 – 7.00 (m, 1H), 1.64 (s, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 163.59, 161.98, 147.07, 146.24, 145.25, 144.59, 136.92, 136.75, 130.03, 129.07, 126.50, 123.12, 121.17, 118.48, 56.16, 25.82. IR (neat) v 3275, 1972, 1651, 1574, 1506, 1473, 1330, 1080, 849, 740, 625 cm^{-1}. HRMS (ESI, m/z): calcd. for $C_{27}H_{23}N_4O_5S_2$ $(M+H)^+$: 547.1110, found: 547.1104.



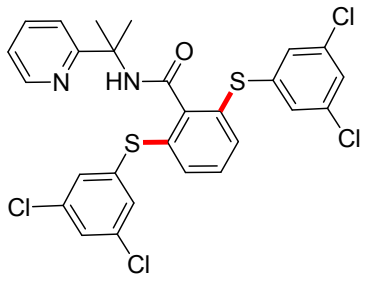
3s

Colorless oil, yield: 85%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.34 – 8.33 (m, 1H), 8.16 (s, 1H), 7.67 (td, J = 8.0, 1.6 Hz, 1H), 7.40 (d, J = 8.0 Hz, 1H), 7.33 – 7.25 (m, 3H), 7.23 – 7.07 (m, 5H), 7.04 – 6.95 (m, 2H), 6.86 – 6.81 (m, 2H), 1.83 (s, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 165.26, 163.72, 162.98 (d, J = 247.0 Hz), 147.06, 144.11, 138.49 (d, J = 8.0 Hz), 137.24, 133.52, 132.88, 130.43 (d, J = 8.0 Hz), 130.12, 125.94 (d, J = 3.0 Hz), 121.84, 119.39, 117.12 (d, J = 23.0 Hz), 113.95 (d, J = 21.0 Hz), 57.46, 27.16. IR (neat) v 3310, 2980, 1662, 1597, 1506, 1472, 1429, 1215, 877, 774, 677 cm^{-1}. HRMS (ESI, m/z): calcd. for $C_{27}H_{23}F_2N_2OS_2$ $(M+H)^+$: 493.1120, found: 493.1121.



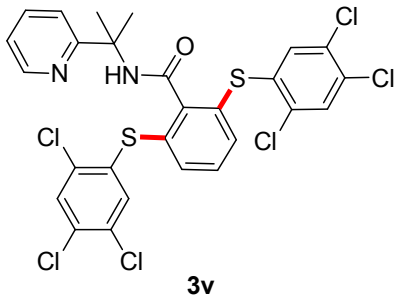
3t

White solid, m.p.: 153-154 °C, yield: 90%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.18 – 8.16 (m, 2H), 8.02 (t, J = 2.0 Hz, 2H), 7.96 – 7.91 (m, 2H), 7.67 (t, J = 7.6 Hz, 1H), 7.56 (d, J = 7.6 Hz, 4H), 7.47 – 7.39 (m, 3H), 7.34 (d, J = 8.0 Hz, 1H), 7.18 – 7.08 (m, 1H), 1.77 (s, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 164.79, 163.36, 148.53, 146.86, 146.79, 139.86, 137.39, 136.24, 134.71, 131.23, 130.86, 129.90, 123.33, 122.00, 121.23, 119.29, 57.33, 26.99. IR (neat) ν 3312, 2982, 1663, 1533, 1344, 1124, 876, 785, 731, 676 cm^{-1}. HRMS (ESI, *m/z*): calcd. for $C_{27}H_{23}N_4O_5S_2$ $(M+H)^+$: 547.1110, found: 547.1105.



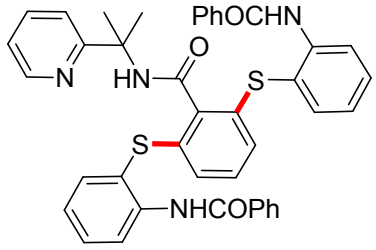
3u

White solid, m.p.: 165-167 °C, yield: 90%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.37 (d, J = 4.4 Hz, 1H), 8.17 (s, 1H), 7.71 (t, J = 7.6 Hz, 1H), 7.51 – 7.32 (m, 4H), 7.22 – 7.14 (m, 1H), 7.13 – 7.07 (m, 6H), 1.82 (s, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 164.81, 163.41, 146.95, 145.72, 140.27, 137.48, 135.41, 135.33, 131.57, 130.57, 127.41, 126.80, 121.95, 119.31, 57.32, 27.03. IR (neat) ν 3329, 2980, 1667, 1473, 1430, 1420, 767, 746, 622 cm^{-1}. HRMS (ESI, *m/z*): calcd. for $C_{27}H_{21}Cl_4N_2OS_2$ $(M+H)^+$: 594.9820, found: 594.9816.



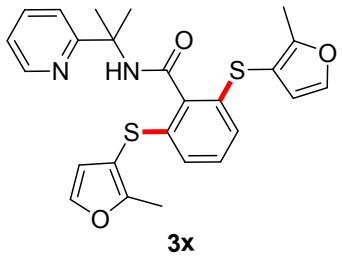
3v

White solid, m.p.: 219-220 °C, yield: 87%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.27 (d, J = 3.6 Hz, 1H), 8.14 (s, 1H), 7.67 (t, J = 7.2 Hz, 1H), 7.56 – 7.44 (m, 3H), 7.33 (d, J = 6.8 Hz, 3H), 7.18 – 7.10 (m, 1H), 6.99 (s, 2H), 1.77 (s, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 164.54, 163.17, 147.15, 146.70, 137.74, 137.09, 136.65, 131.86, 131.22, 131.03, 130.67, 130.60, 130.44, 130.34, 121.95, 119.33, 57.13, 26.93. IR (neat) v 3300, 2969, 1661, 1507, 1432, 1156, 1055, 887, 871, 787, 757, 638, 621 cm^{-1}. HRMS (ESI, *m/z*): calcd. for $C_{27}H_{19}Cl_6N_2OS_2$ $(M+H)^+$: 662.9040, found: 662.9023.



3w

White solid, m.p.: 191-193 °C, yield: 88%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.16 (s, 2H), 8.65 – 8.63 (m, 3H), 8.31 (d, J = 4.4 Hz, 1H), 8.78 – 8.74 (m, 5H), 7.61 (dd, J = 7.6, 0.8 Hz, 2H), 7.52 – 7.35 (m, 3H), 7.19 (dd, J = 6.8, 5.2 Hz, 1H), 7.13 (t, J = 7.6 Hz, 2H), 6.94 (t, J = 8.0 Hz, 1H), 6.64 (d, J = 8.0 Hz, 2H), 1.99 (s, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 165.29, 165.05, 163.81, 147.26, 140.18, 137.40, 136.83, 136.21, 134.87, 134.35, 131.93, 131.31, 130.21, 128.79, 127.18, 125.44, 124.67, 122.09, 121.13, 119.95, 119.62, 57.74, 27.45. IR (neat) v 3372, 2974, 1658, 1515, 1424, 1300, 1251, 757, 700 cm^{-1}. HRMS (ESI, *m/z*): calcd. for $C_{41}H_{34}N_4O_3S_2Na$ $(M+Na)^+$: 717.1970, found: 717.1982.



3x

Yellow solid, m.p.: 115-116 °C, yield: 94%. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.53 – 8.45 (m, 1H), 8.39 (s, 1H), 7.75 (td, J = 8.0, 1.6 Hz, 1H), 7.56 (d, J = 8.0 Hz, 1H), 7.34 (d, J = 2.0 Hz, 2H), 7.23 – 7.16 (m, 1H), 7.01 (t, J = 8.0 Hz, 1H), 6.69 (d, J = 8.0 Hz, 2H), 6.38 (d, J = 2.0 Hz, 2H), 2.33 (s, 6H), 2.01 (s, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 165.53, 164.29, 157.29, 147.36, 141.28, 137.17, 136.84, 134.68, 129.06, 123.66, 121.91, 119.69, 115.50, 107.73, 57.71, 27.50, 11.84. IR (neat) v 3329, 3296, 2923, 1658, 1498, 1429, 1120, 1087, 885, 792, 668, 658 cm^{-1}. HRMS (ESI, *m/z*): calcd. for $C_{25}H_{25}N_2O_3S_2$ $(M+H)^+$: 465.1307, found: 465.1303.

III. References and notes:

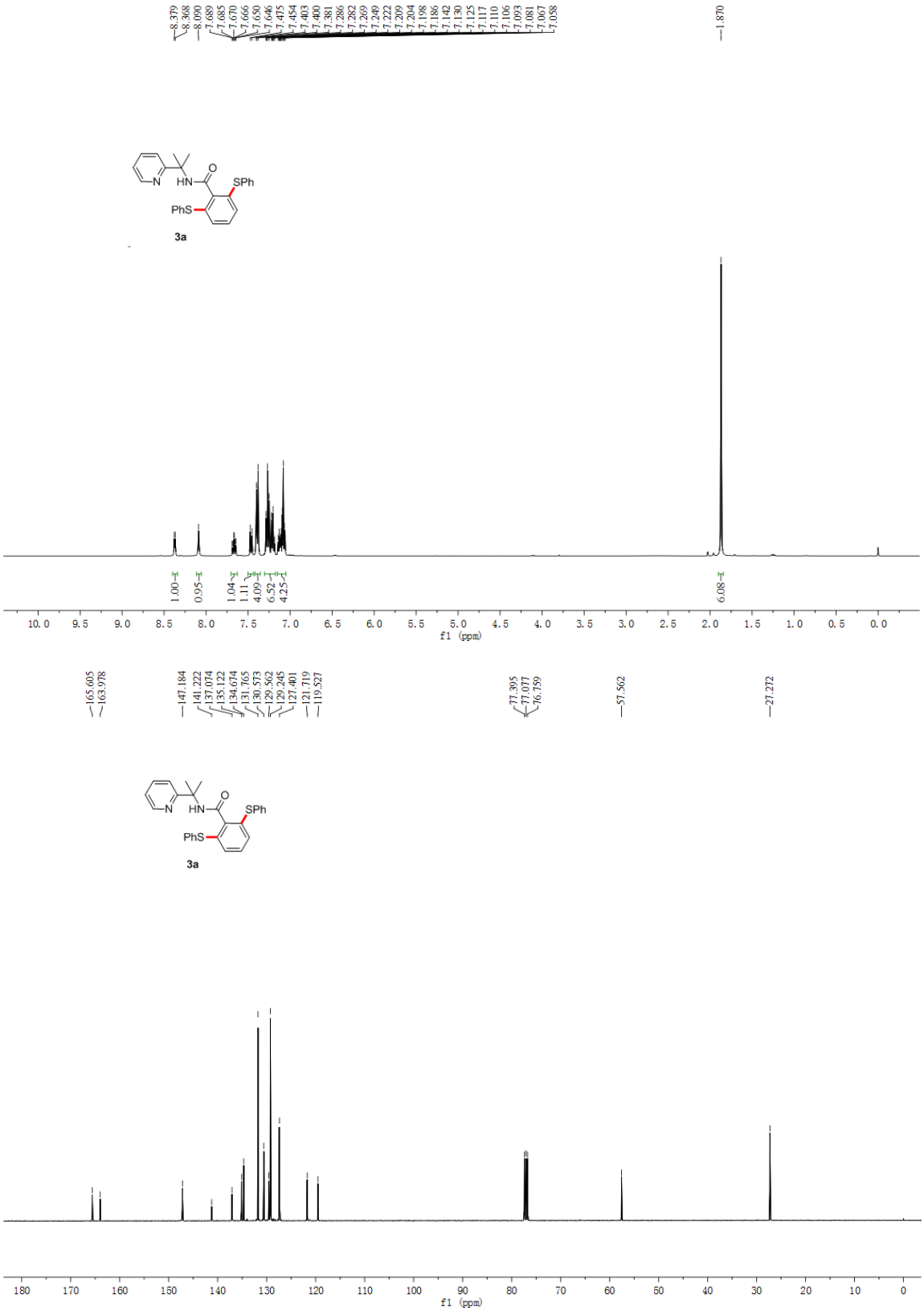
(1) Q. Zhang, K. Chen, W. H. Rao, Y. Zhang, F. J. Chen, B.-F. Shi, *Angew. Chem.*, *Int. Ed.*, 2013, **52**, 13588.

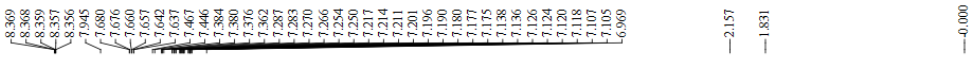
(2) F. J. Chen, G. Liao, X. Li, J. Wu, B.-F. Shi, *Org. Lett.*, 2014, **16**, 5644.

(3) X. Li, Y. H. Liu, W. J. Gu, B. Li, F. J. Chen, B.-F. Shi, *Org. Lett.*, 2014, **16**, 3904;

(4) V. Valenta, J. Jílek, J. Pomykáček, A. Dlabač, M. Valchář, J. Metyš, M. Protiva, *Collect. Czech. Chem. Commun.* 1979, **44,** 2677.

IV. ^{1}H and ^{13}C NMR Spectra




8.369
8.368
8.359
8.357
8.356
7.945
7.680
7.676
7.660
7.657
7.642
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7.467
7.446
7.384
7.380
7.376
7.362
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7.254
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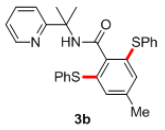
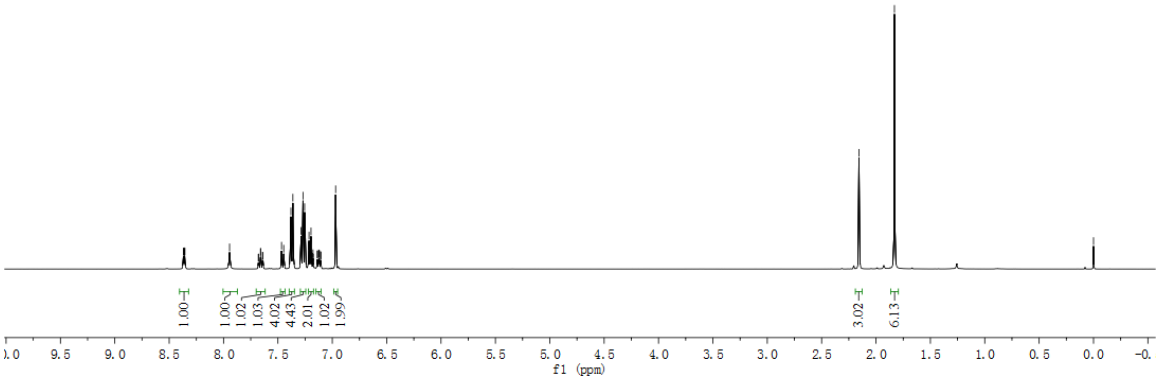
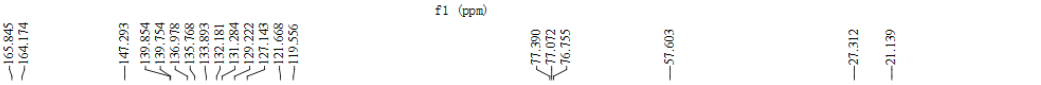
7.105
6.969
2.157
1.831
0.000


N
HN
O
SPh
PhS
Me

3b


1.00
1.00
1.02
1.03
4.02
4.43
2.01
1.02
1.99
3.02
6.13
f1 (ppm)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164.174
147.293
139.854
139.754
136.978
135.768
133.893
132.181
131.284
129.222
127.143
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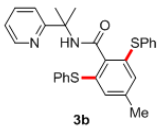
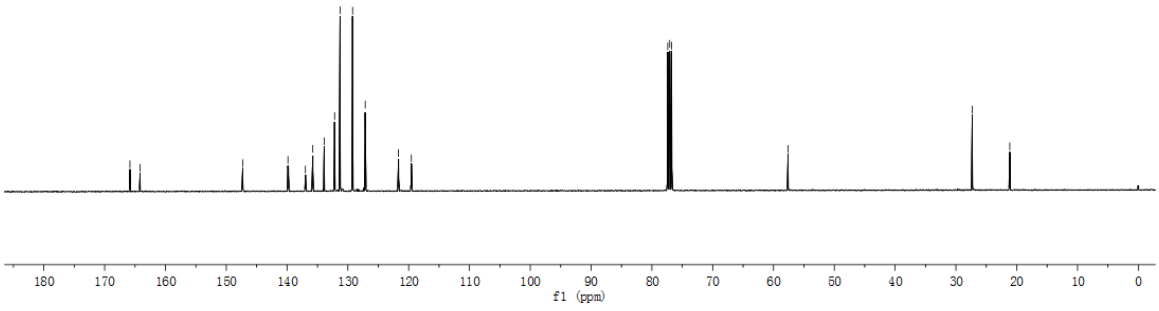
119.556
77.390
77.072
76.755
57.603
27.312
21.139


N
HN
O
SPh
PhS
Me

3b


f1 (ppm)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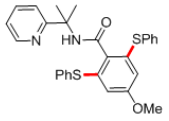
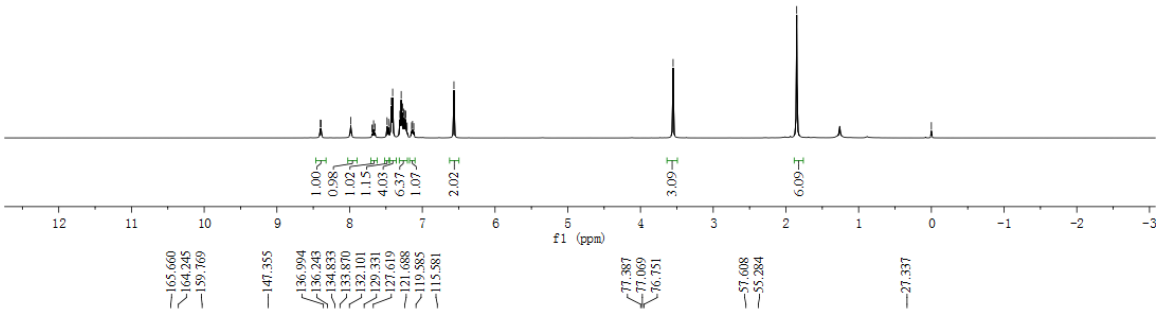
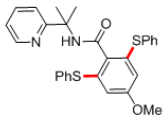
8.302
7.984
7.690
7.687
7.670
7.652
7.485
7.465
7.426
7.408
7.309
7.291
7.272
7.255
7.245
7.227
7.209
7.148
7.135
7.118
6.565
3.552
1.852
0.000

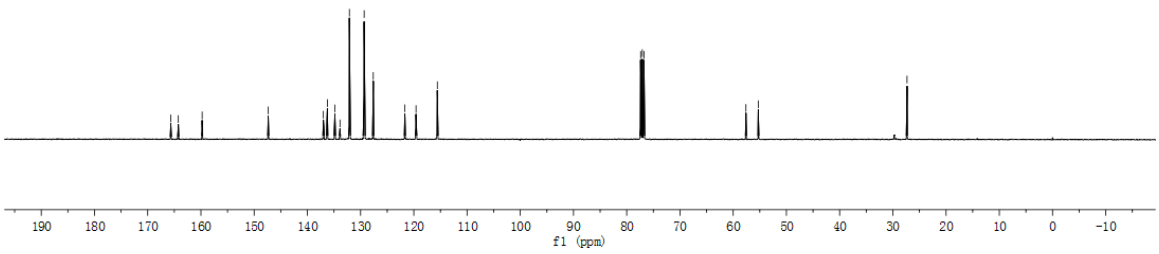

HN
O
SPh
PhS
OMe

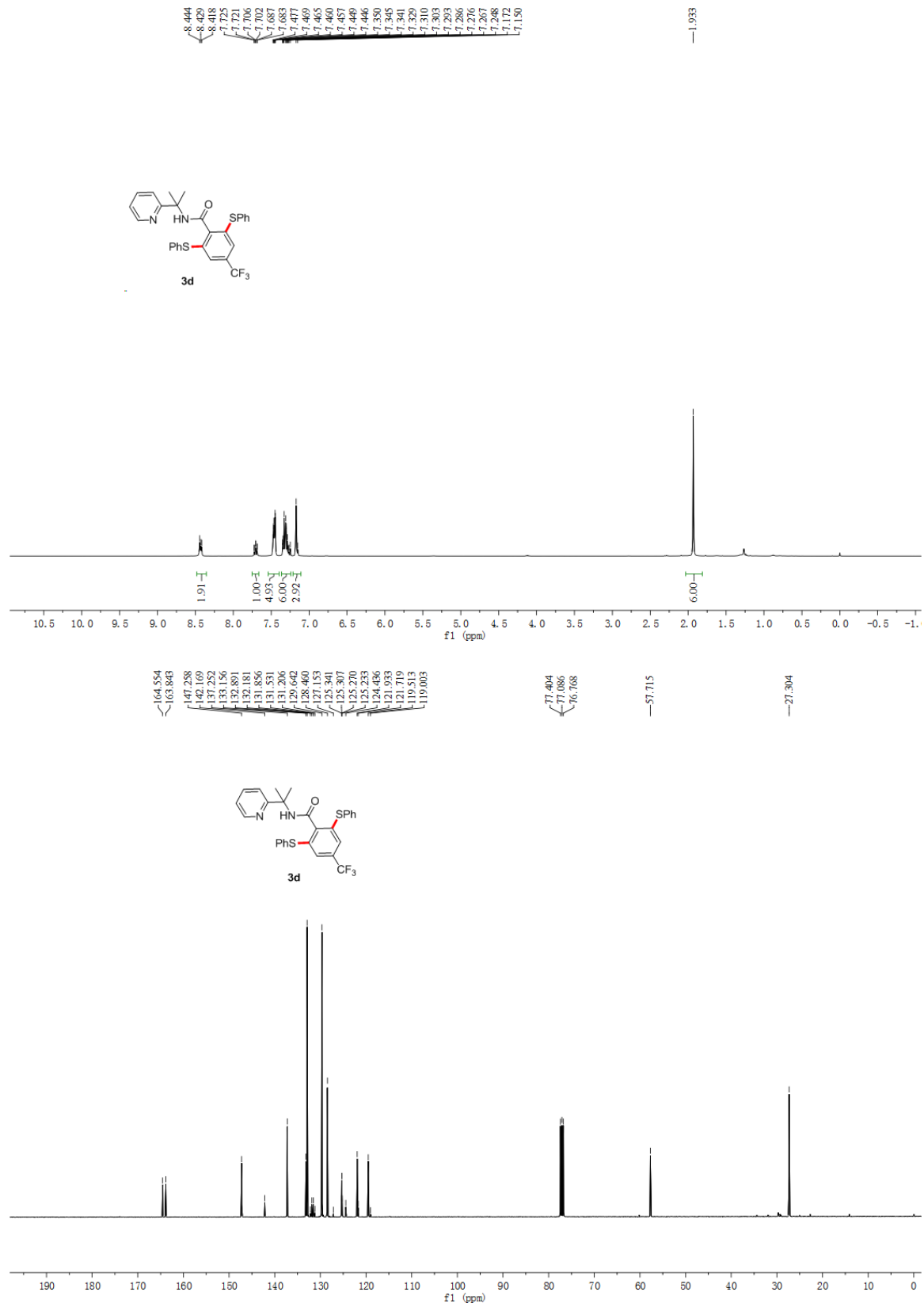
3c


1.00
0.98
1.02
1.15
4.03
6.37
1.07
2.02
3.09
6.09
f1 (ppm)
165.660
164.245
159.769
147.355
136.994
136.243
134.833
133.870
132.101
129.331
127.619
121.688
119.585
115.581
77.387
77.069
76.751
57.608
55.284
27.337


HN
O
SPh
PhS
OMe

3c


f1 (ppm)


8.444
8.429
8.418
7.725
7.721
7.706
7.702
7.687
7.683
7.477
7.469
7.465
7.460
7.457
7.449
7.446
7.350
7.345
7.341
7.329
7.310
7.303
7.293
7.286
7.276
7.267
7.248
7.172
7.150
1.933
HN
O
SPh
PhS
CF3
3d
1.91
1.00
4.93
6.00
2.92
6.00
f1 (ppm)
164.554
163.843
147.258
142.169
137.252
133.156
132.891
132.181
131.856
131.531
131.206
129.642
128.460
127.153
125.341
125.307
125.270
125.233
124.496
121.933
121.719
119.513
119.003
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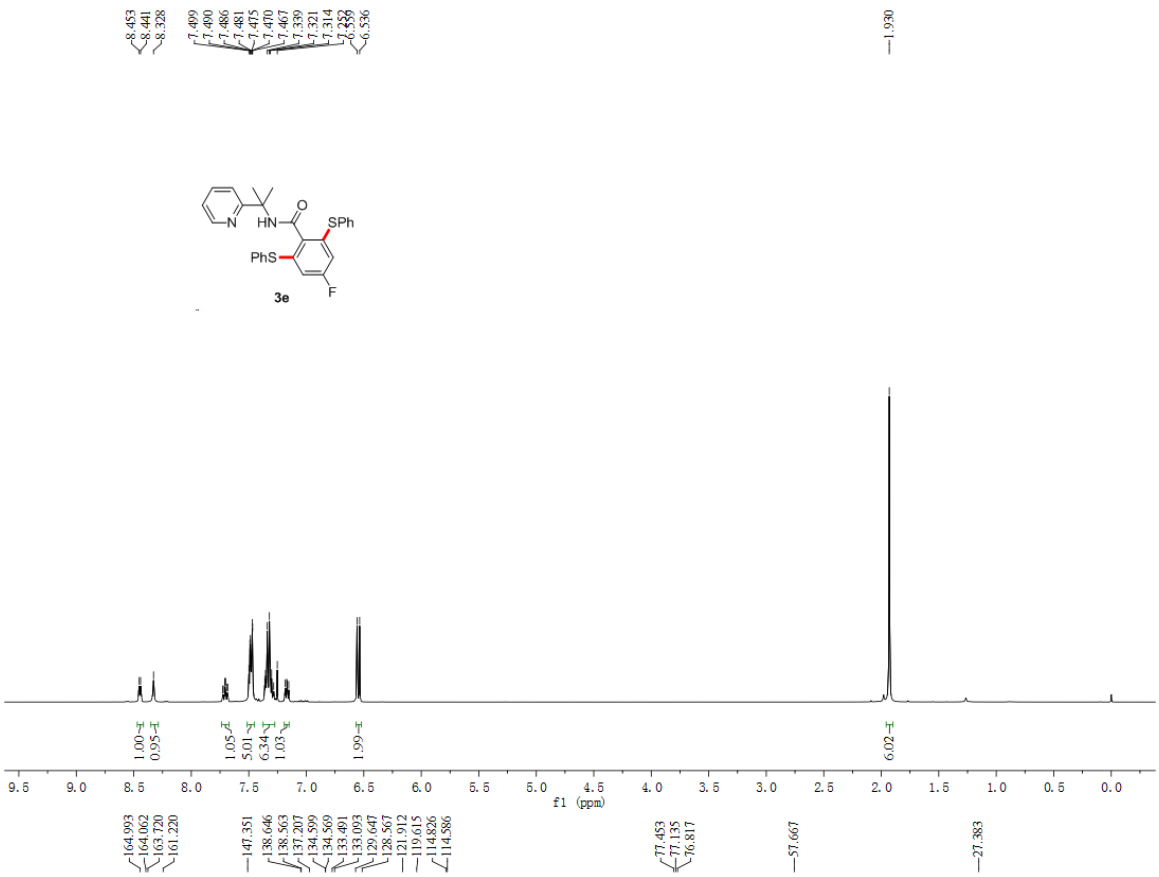
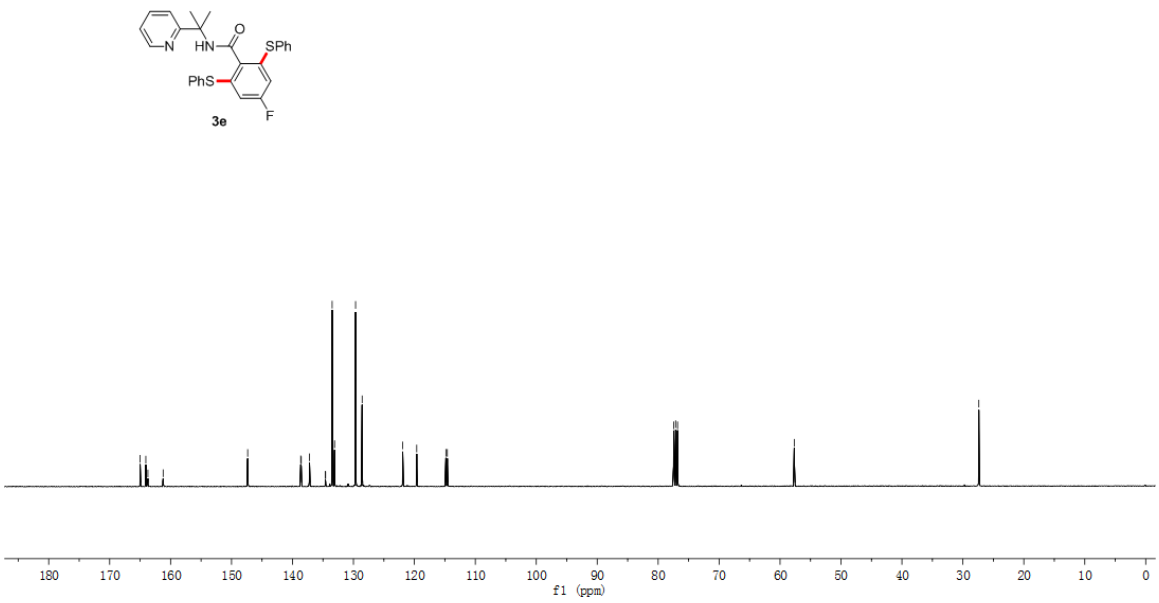
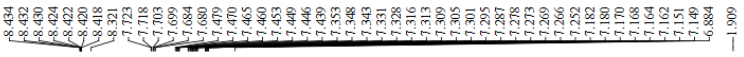
77.086
76.768
57.715
27.304
HN
O
SPh
PhS
CF3
3d
f1 (ppm)


8.453
8.441
8.328
7.499
7.490
7.486
7.481
7.475
7.470
7.467
7.339
7.321
7.314
7.155
7.139
6.536
1.930
SPh
PhS
F
3e
1.00
0.95
1.05
5.01
6.34
1.03
1.99
6.02
f1 (ppm)
164.993
164.062
163.720
161.220
147.351
138.646
138.563
137.207
134.599
134.569
133.491
133.093
129.647
128.567
121.912
119.615
114.826
114.586
77.453
77.135
76.817
57.667
27.383


SPh
PhS
F
3e
f1 (ppm)


8.434
8.432
8.430
8.424
8.422
8.420
8.418
8.321
7.723
7.718
7.703
7.699
7.684
7.680
7.479
7.470
7.465
7.460
7.453
7.449
7.446
7.439
7.353
7.348
7.343
7.331
7.328
7.316
7.313
7.309
7.305
7.301
7.295
7.287
7.278
7.273
7.269
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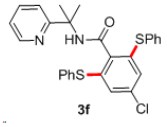
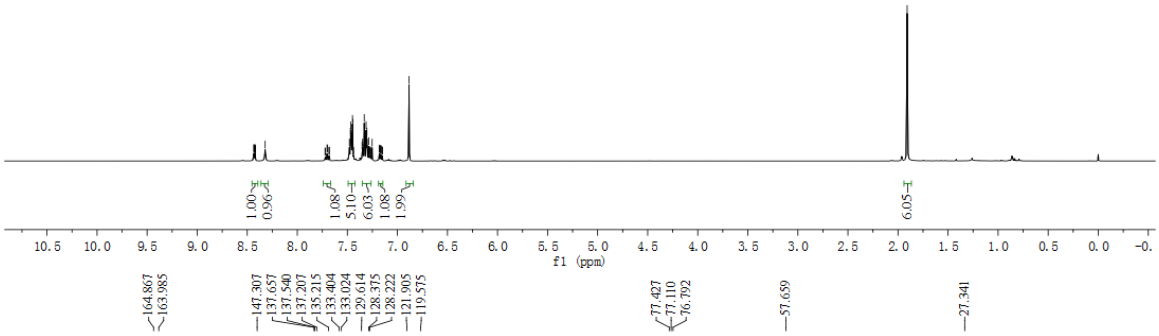
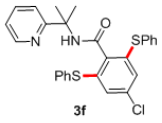
7.182
7.180
7.170
7.168
7.164
7.162
7.151
7.149
6.884
1.909

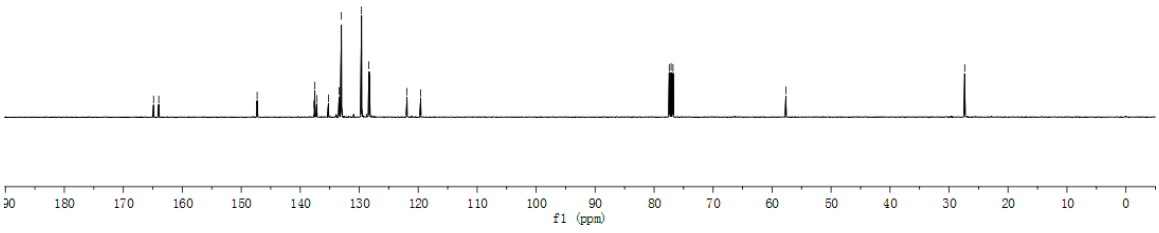

HN
O
SPh
PhS
Cl

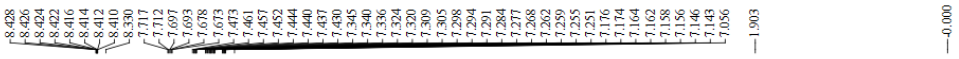
3f


1.00
0.96
1.08
5.10
6.03
1.08
1.99
6.05
10.5 10.0 9.5 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 -0.
f1 (ppm)
164.867
163.985
147.307
137.657
137.540
137.207
135.215
133.404
133.024
129.614
128.375
128.222
121.905
119.575
77.427
77.110
76.792
57.659
27.341


HN
O
SPh
PhS
Cl

3f


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


8.428
8.426
8.424
8.422
8.416
8.414
8.412
8.410
8.330
7.717
7.712
7.697
7.693
7.678
7.673
7.473
7.461
7.457
7.452
7.444
7.440
7.437
7.430
7.345
7.340
7.336
7.324
7.320
7.309
7.305
7.298
7.294
7.291
7.284
7.277
7.268
7.262
7.259
7.255
7.251
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7.174
7.164
7.162
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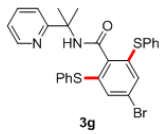
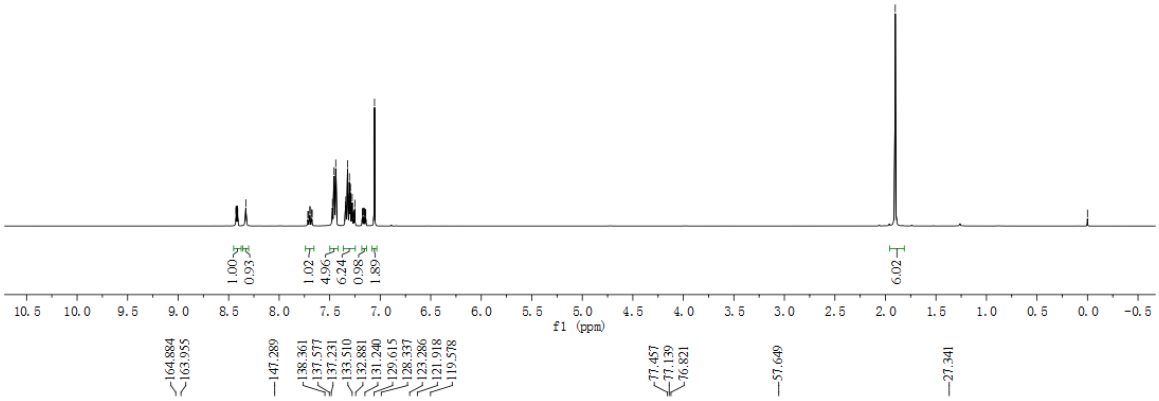
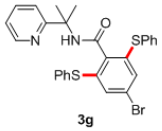
7.156
7.146
7.143
7.056
1.903
0.000


HN
O
SPh
PhS
Br

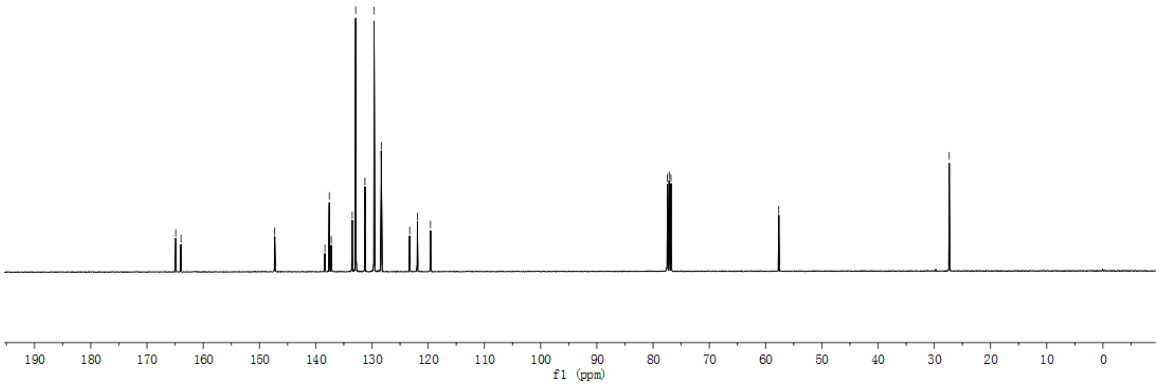
3g

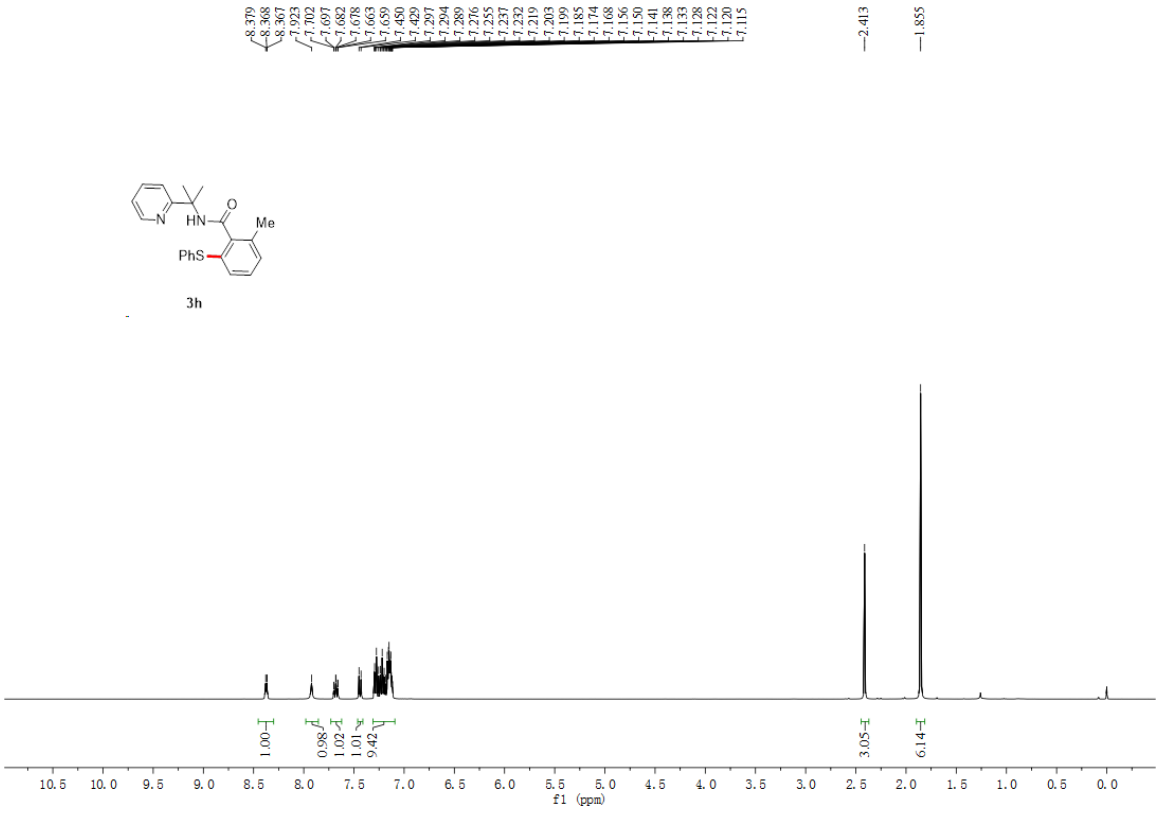

1.00
0.93
1.02
4.96
6.24
0.98
1.89
6.02
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

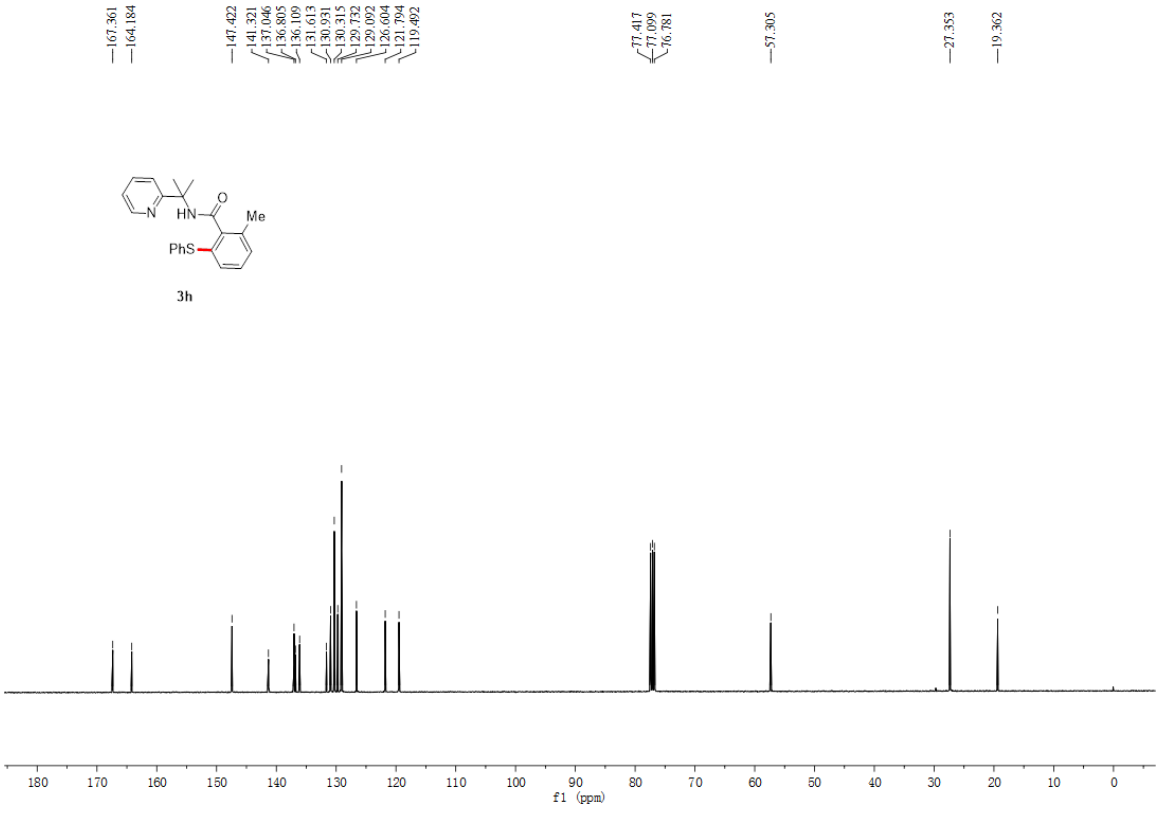
164.884
163.955
147.289
138.361
137.577
137.231
133.510
132.881
131.240
129.615
128.337
123.286
121.918
119.578
77.457
77.139
76.821
57.649
27.341

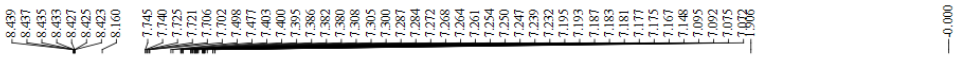

HN
O
SPh
PhS
Br

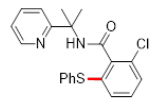
3g


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

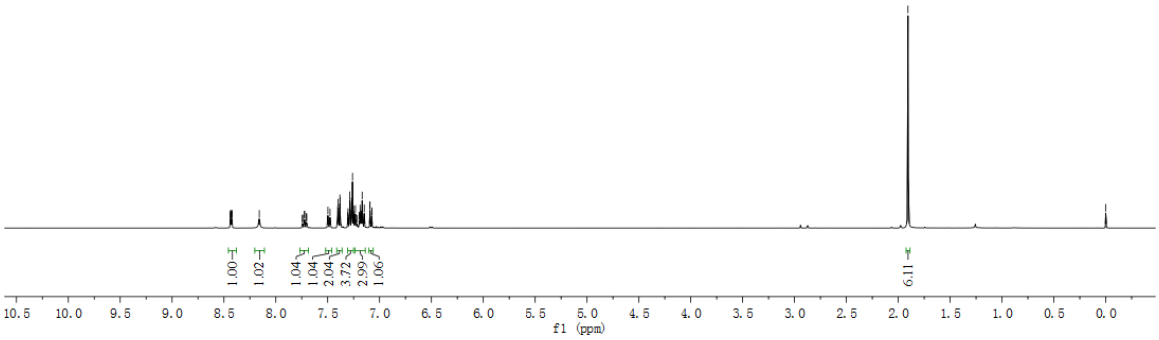

8.379
8.368
8.367
7.923
7.702
7.697
7.682
7.678
7.663
7.659
7.450
7.429
7.297
7.294
7.289
7.276
7.255
7.237
7.232
7.219
7.203
7.199
7.185
7.174
7.168
7.156
7.150
7.141
7.138
7.133
7.128
7.122
7.120
7.115
2.413
1.855
HN
O
Me
PhS
3h
1.00
0.98
1.02
1.01
9.42
3.05
6.14
f1 (ppm)

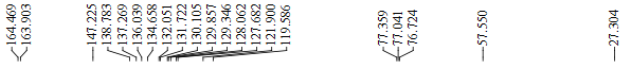

167.361
164.184
147.422
141.321
137.046
136.805
136.109
131.613
130.931
130.315
129.732
129.092
126.604
121.794
119.492
77.417
77.099
76.781
57.305
27.353
19.362
HN
O
Me
PhS
3h
f1 (ppm)

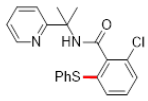

8.439
8.437
8.435
8.433
8.427
8.425
8.423
8.160
7.745
7.740
7.725
7.721
7.706
7.702
7.498
7.477
7.403
7.400
7.395
7.386
7.382
7.380
7.308
7.305
7.300
7.287
7.284
7.272
7.268
7.264
7.261
7.254
7.250
7.247
7.239
7.232
7.195
7.193
7.187
7.183
7.181
7.177
7.175
7.167
7.148
7.095
7.092
7.075
7.072
1.906
0.000


N
HN
O
Cl
PhS

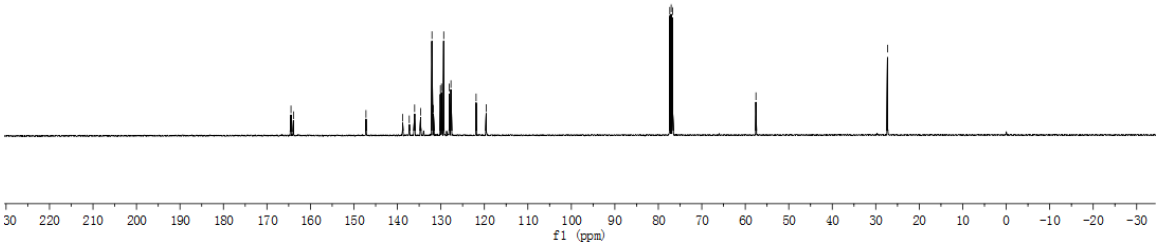
3i

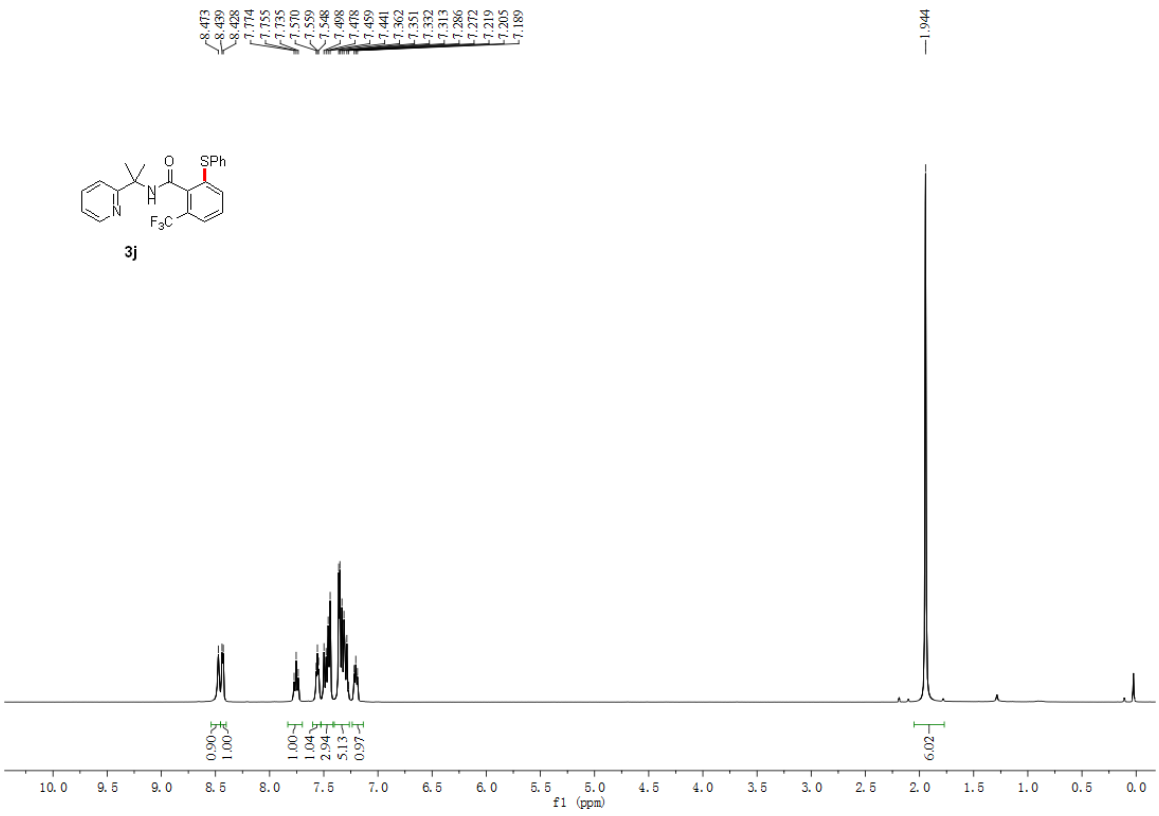

1.00
1.02
1.04
1.04
2.04
3.72
2.99
1.06
6.11
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

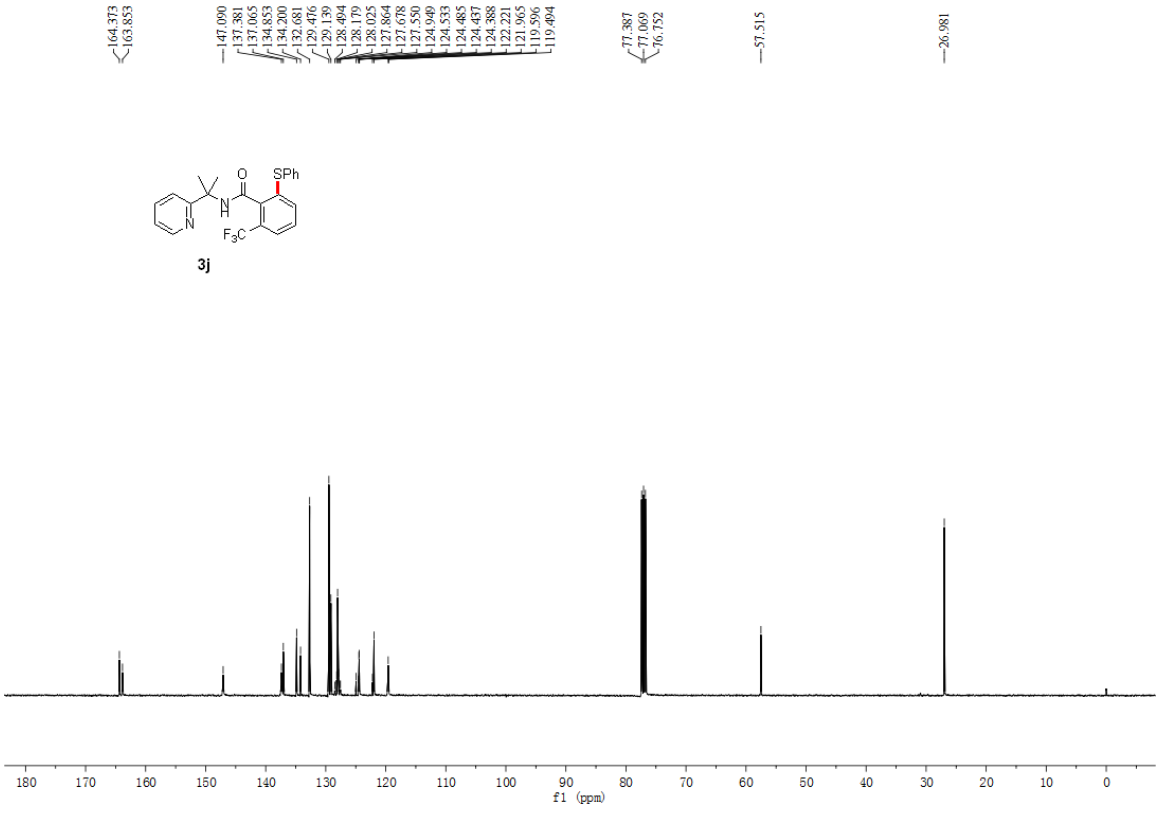

164.469
163.903
147.225
138.783
137.269
136.039
134.658
132.051
131.722
130.105
129.857
129.346
128.062
127.682
121.900
119.386
77.359
77.041
76.724
57.550
27.304

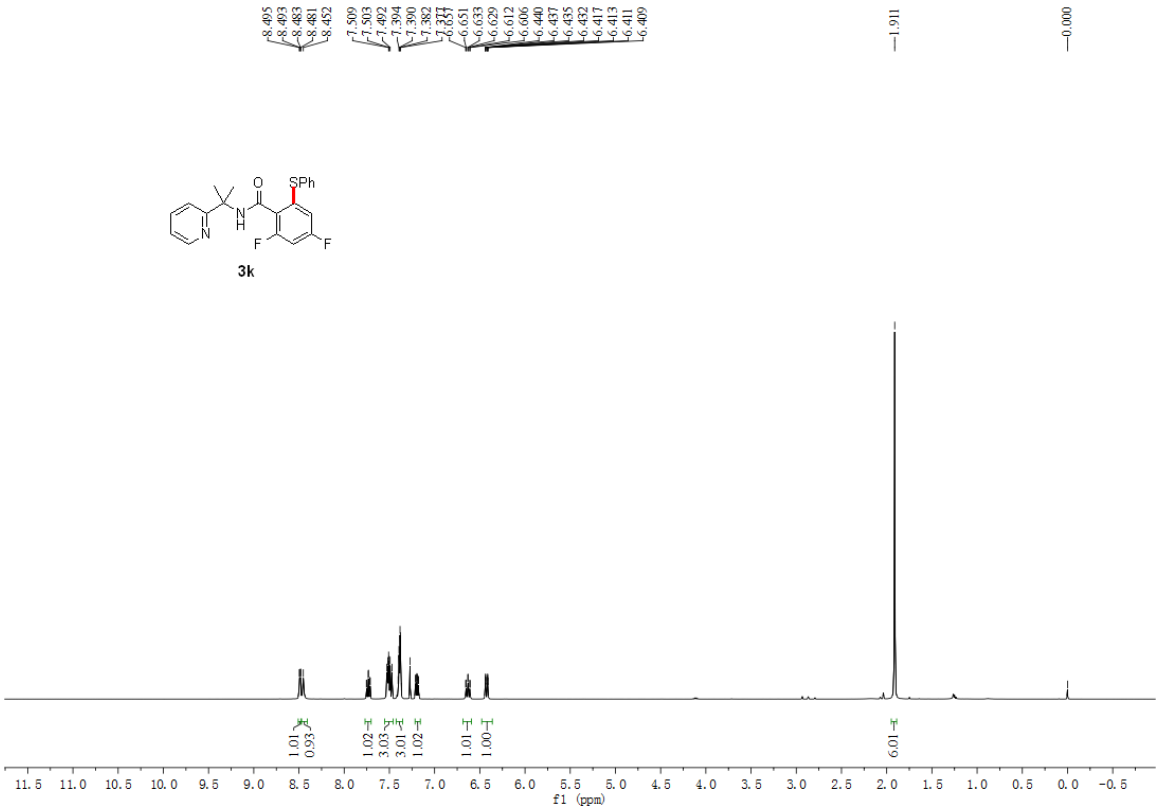

N
HN
O
Cl
PhS

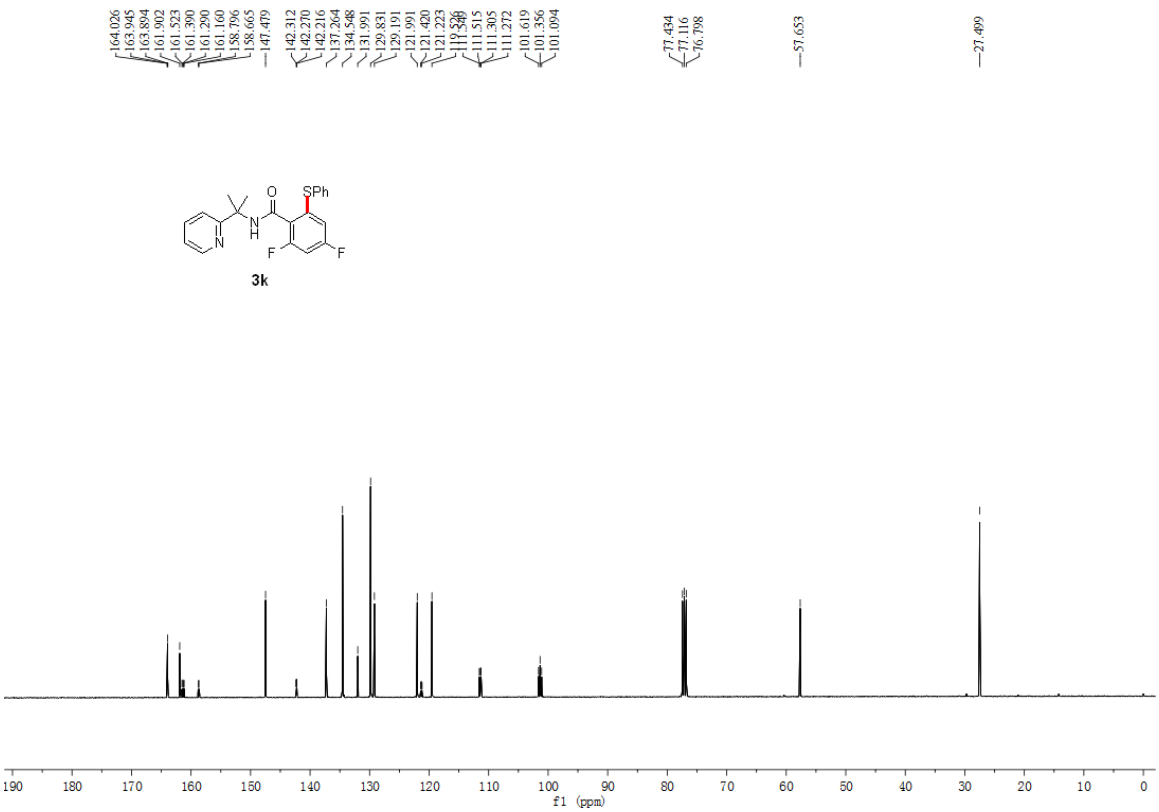
3i


230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10 -20 -30
f1 (ppm)

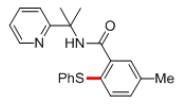

8.473
8.439
8.428
7.774
7.755
7.735
7.570
7.559
7.548
7.498
7.478
7.459
7.441
7.362
7.351
7.332
7.313
7.286
7.272
7.219
7.205
7.189
1.944
SPh
O
N
H
F3C
3j
0.90
1.00
1.00
1.04
2.94
5.13
0.97
6.02
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


164.373
163.853
147.090
137.381
137.065
134.853
134.200
132.681
129.476
129.139
128.494
128.179
128.025
127.864
127.678
127.550
124.949
124.533
124.485
124.437
124.388
122.221
121.965
119.596
119.494
77.387
77.069
76.752
57.515
26.981
SPh
O
N
H
F3C
3j
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

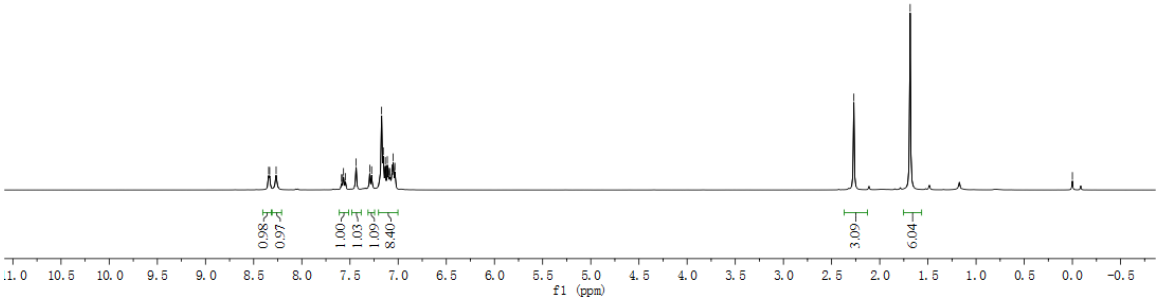

8.495
8.493
8.483
8.481
8.452
7.509
7.503
7.492
7.394
7.390
7.382
6.651
6.633
6.629
6.612
6.606
6.440
6.437
6.435
6.432
6.417
6.413
6.411
6.409
1.911
0.000
SPh
O
N
H
F
F
3k
1.01
0.93
1.02
3.03
3.01
1.02
1.01
1.00
6.01
f1 (ppm)


164.026
163.945
163.894
161.902
161.523
161.390
161.290
161.160
158.796
158.665
147.479
142.312
142.270
142.216
137.264
134.548
131.991
129.831
129.191
121.991
121.420
121.223
111.515
111.305
111.272
101.619
101.356
101.094
77.434
77.116
76.798
57.653
27.499
SPh
O
N
H
F
F
3k
f1 (ppm)

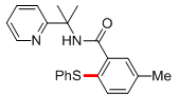

8.344
8.334
8.267
7.587
7.584
7.567
7.549
7.437
7.295
7.275
7.172
7.154
7.133
7.113
7.099
7.093
7.083
7.064
7.052
7.034
2.269
1.684
0.000


HN
O
PhS
Me

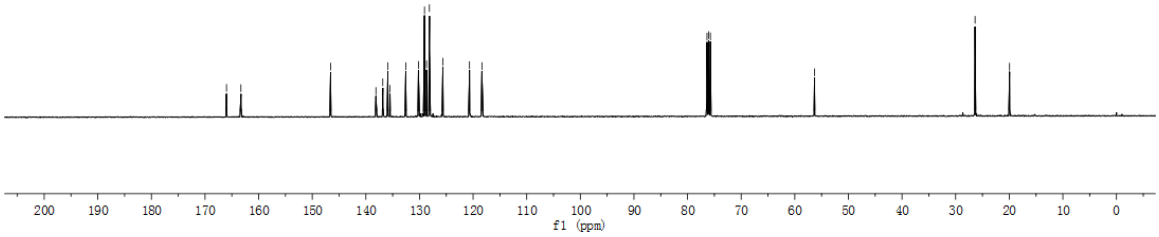
3l

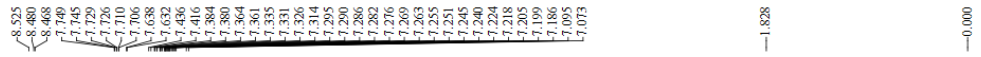

0.98
0.97
1.00
1.03
1.09
8.40
3.09
6.04
f1 (ppm)

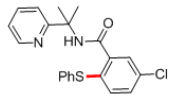

165.997
163.307
146.588
138.123
136.844
135.908
135.491
132.566
130.198
129.064
128.670
128.150
128.027
125.643
120.669
118.357
76.375
76.057
75.739
56.321
26.372
19.943


HN
O
PhS
Me

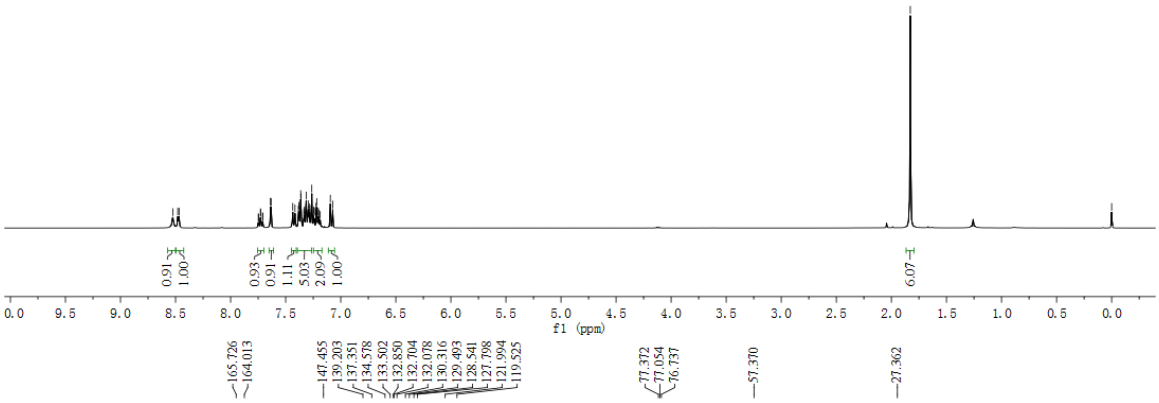
3l


f1 (ppm)


8.525
8.480
8.468
7.749
7.745
7.729
7.726
7.710
7.706
7.638
7.632
7.436
7.416
7.384
7.380
7.364
7.361
7.335
7.331
7.326
7.314
7.295
7.290
7.286
7.282
7.276
7.269
7.263
7.255
7.251
7.245
7.240
7.224
7.218
7.205
7.199
7.186
7.095
7.073
1.828
0.000


HN
O
PhS
Cl

3ma


0.91
1.00
0.93
0.91
1.11
5.03
2.09
1.00
6.07
0.0
9.5
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)

165.726
164.013
147.455
139.203
137.351
134.578
133.502
132.850
132.704
132.078
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128.541
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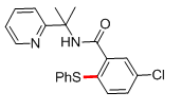
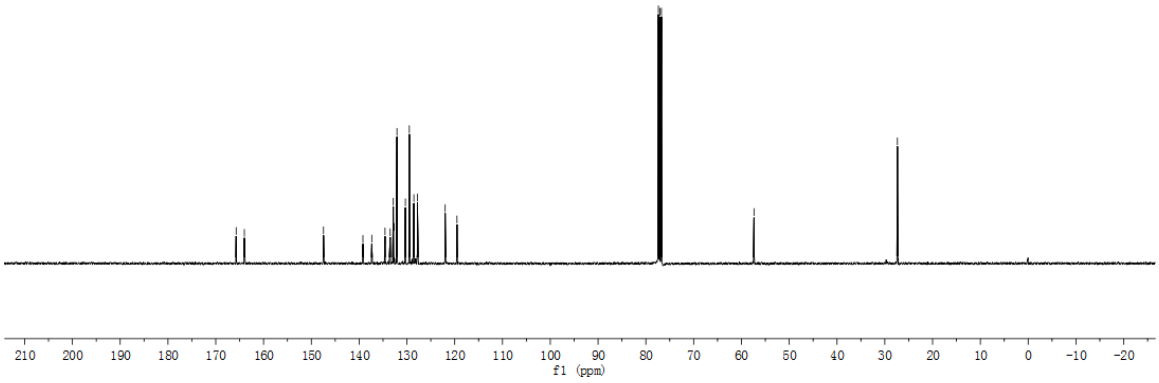
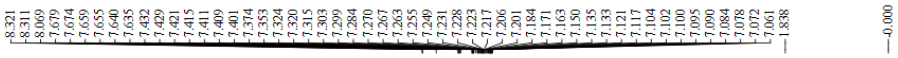
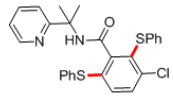
119.525
77.372
77.054
76.737
57.370
27.362


HN
O
PhS
Cl

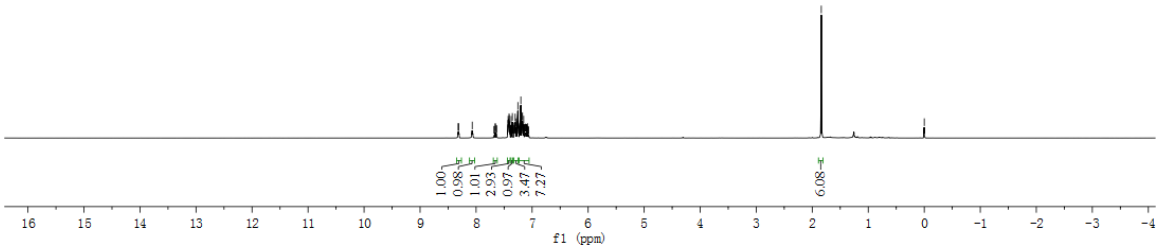
3ma


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

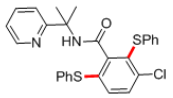

8.321
8.311
8.069
7.679
7.674
7.659
7.655
7.640
7.635
7.432
7.429
7.421
7.415
7.411
7.409
7.401
7.374
7.353
7.324
7.320
7.315
7.303
7.299
7.284
7.270
7.267
7.263
7.255
7.249
7.231
7.228
7.223
7.217
7.206
7.201
7.184
7.171
7.163
7.150
7.135
7.133
7.121
7.117
7.104
7.102
7.100
7.095
7.090
7.084
7.078
7.072
7.061
1.838
0.000


HN
O
SPh
PhS
Cl

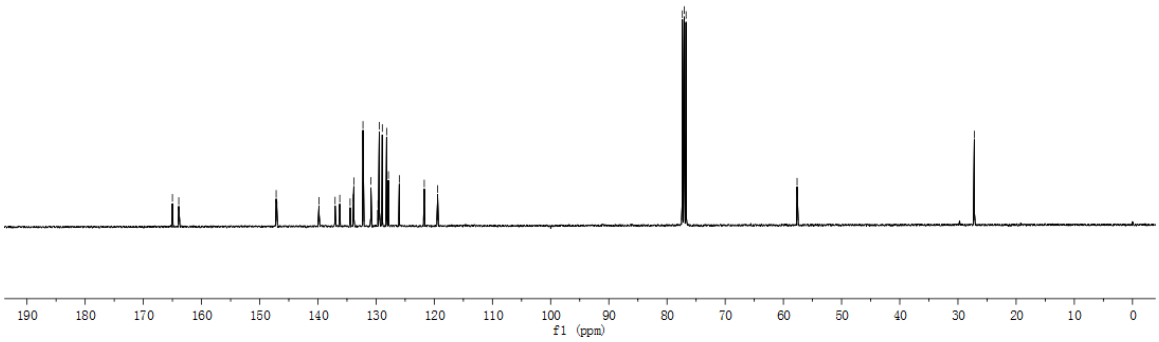
3mb

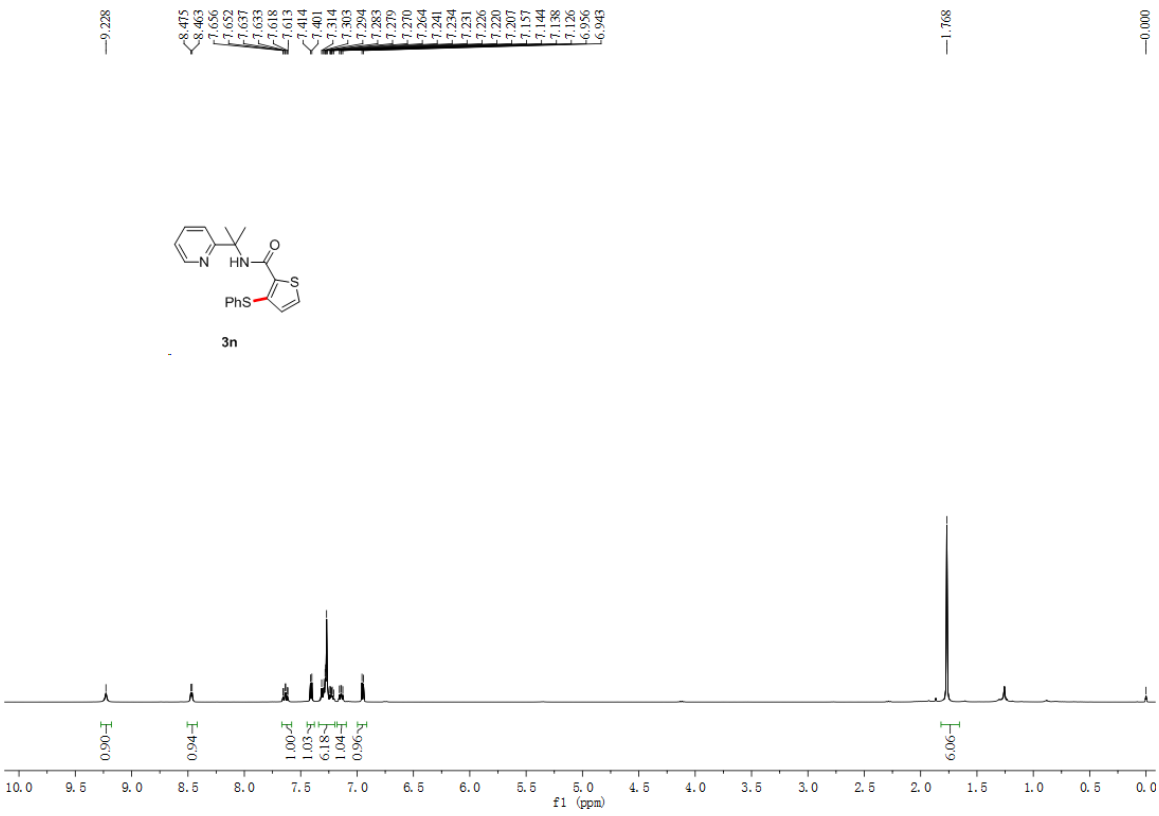

1.00
0.98
1.01
2.93
0.97
3.47
7.27
6.08
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
−1
−2
−3
−4
f1 (ppm)

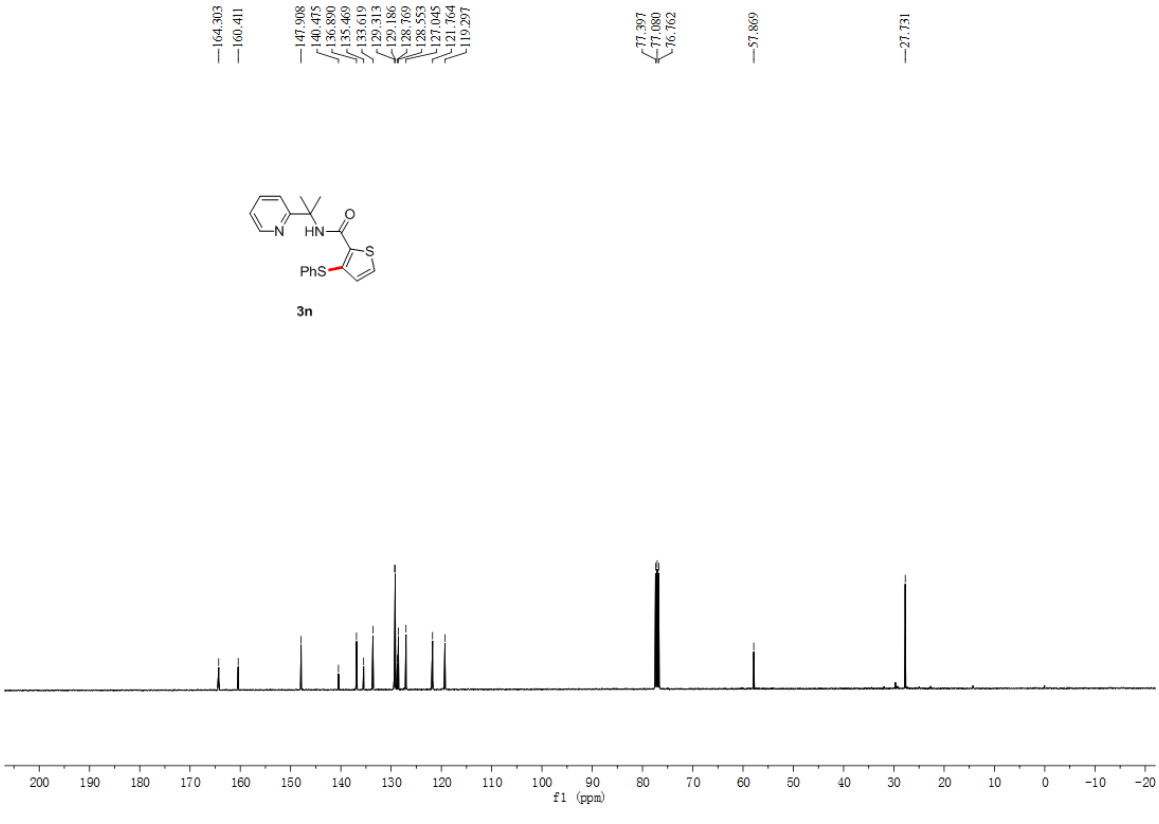

164.999
163.912
147.172
147.041
139.816
137.042
136.243
134.463
133.911
133.826
132.250
130.880
129.666
129.452
128.929
128.187
127.881
126.007
121.719
119.431
77.360
77.042
76.725
57.648
27.191

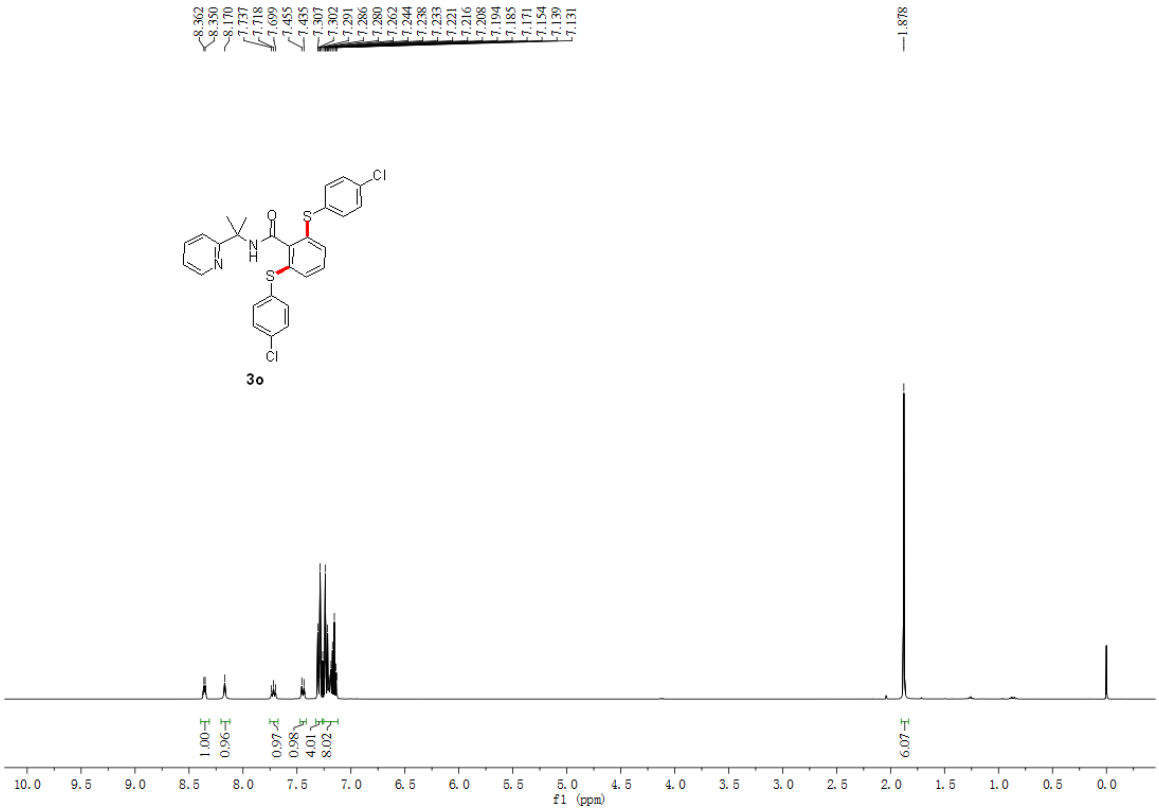

HN
O
SPh
PhS
Cl

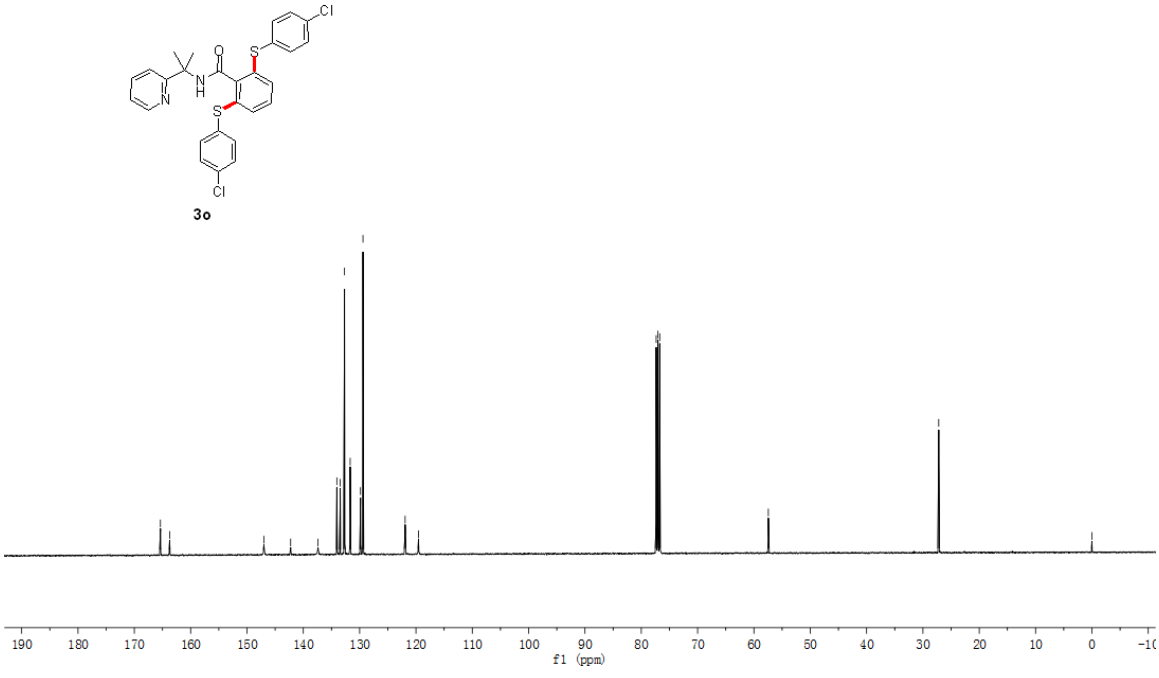
3mb

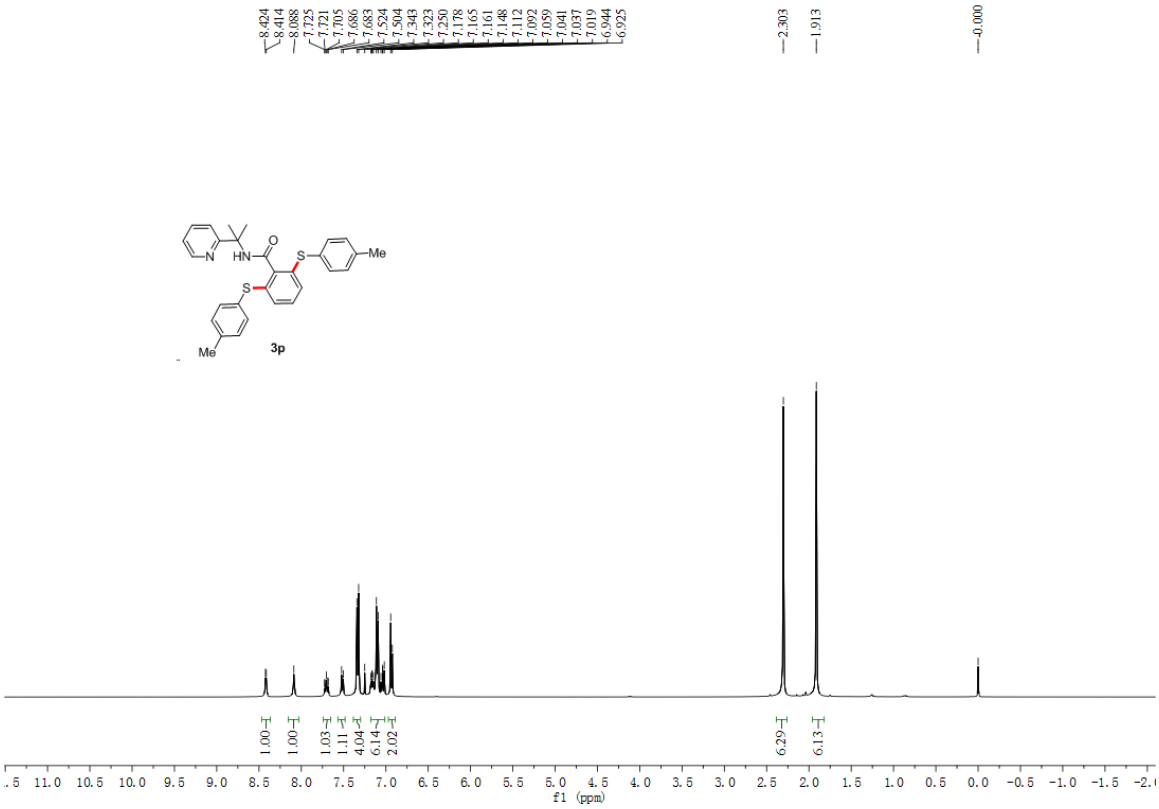

190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

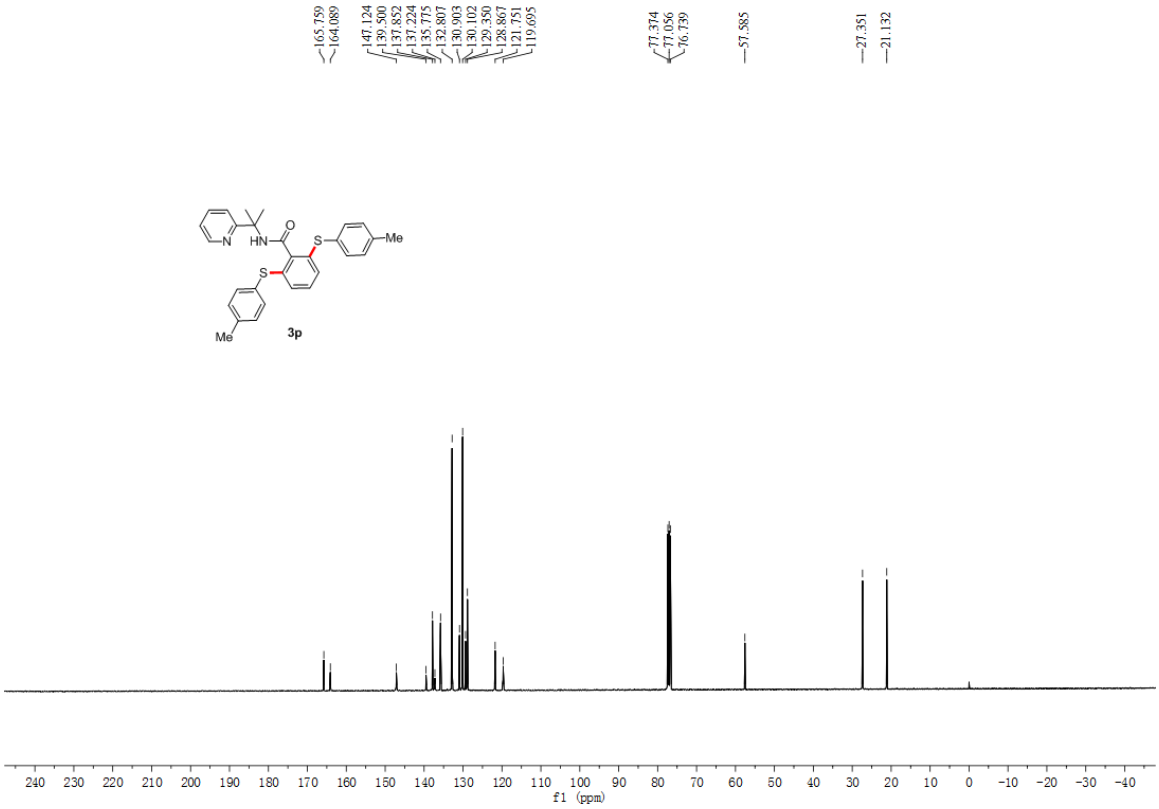

9.228
8.475
8.463
7.656
7.652
7.637
7.633
7.618
7.613
7.414
7.401
7.314
7.303
7.294
7.283
7.279
7.270
7.264
7.241
7.234
7.231
7.226
7.220
7.207
7.157
7.144
7.138
7.126
6.956
6.943
1.768
0.000
N
HN
O
S
PhS
3n
0.90
0.94
1.00
1.03
6.18
1.04
0.96
6.06
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

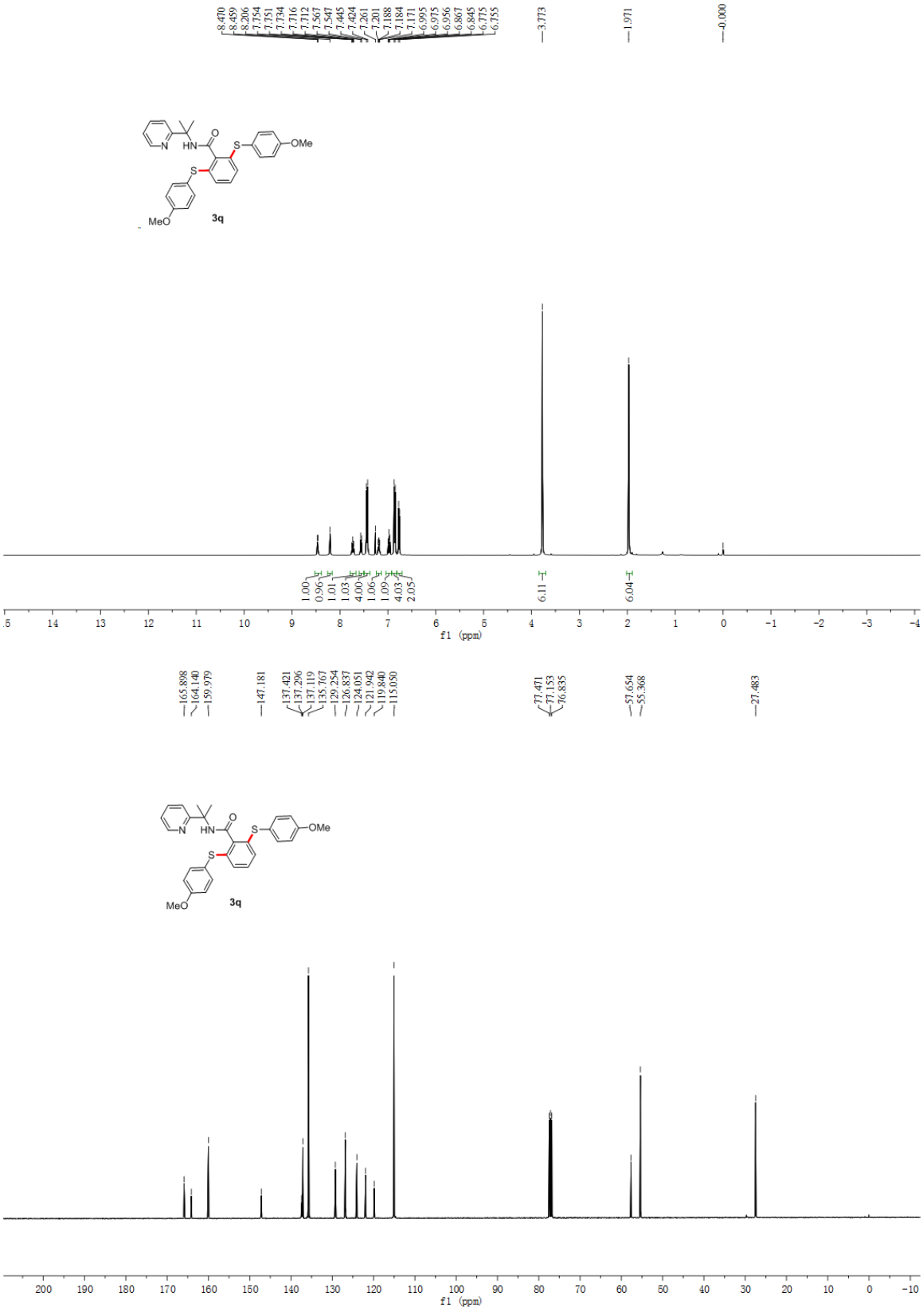

164.303
160.411
147.908
140.475
136.890
135.469
133.619
129.313
129.186
128.769
128.553
127.045
121.764
119.297
77.397
77.080
76.762
57.869
27.731
N
HN
O
S
PhS
3n
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10 -20
f1 (ppm)

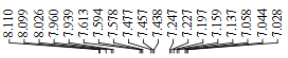

8.362
8.350
8.170
7.737
7.718
7.699
7.455
7.435
7.307
7.302
7.291
7.286
7.280
7.262
7.244
7.238
7.233
7.221
7.216
7.208
7.194
7.185
7.171
7.154
7.139
7.131
1.878
Cl
S
O
N
H
S
Cl
3o
1.00
0.96
0.97
0.98
4.01
8.02
6.07
f1 (ppm)

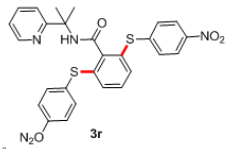

165.363
163.726
146.995
142.246
137.387
134.048
134.000
133.438
132.681
131.676
129.846
129.403
121.922
119.551
77.357
77.039
76.722
57.442
27.193
0.000
Cl
S
O
N
H
S
Cl
3o
f1 (ppm)

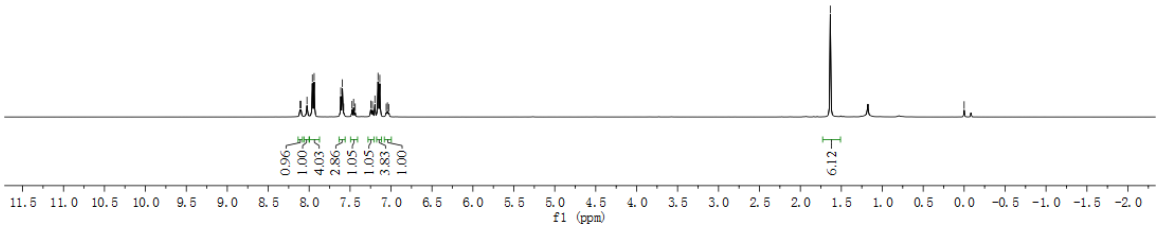

8.424
8.414
8.088
7.725
7.721
7.705
7.686
7.683
7.524
7.504
7.343
7.323
7.250
7.178
7.165
7.161
7.148
7.112
7.092
7.059
7.041
7.037
7.019
6.944
6.925
2.303
1.913
0.000
Me
S
HN
O
N
Me
3p
1.00
1.00
1.03
1.11
4.04
6.14
2.02
6.29
6.13
f1 (ppm)


165.759
164.089
147.124
139.500
137.852
137.224
135.775
132.807
130.903
130.102
129.350
128.867
121.751
119.695
77.374
77.056
76.739
57.585
27.351
21.132
Me
S
HN
O
N
Me
3p
f1 (ppm)

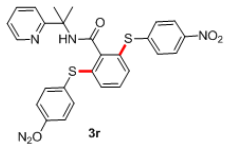

8.470
8.459
8.206
7.754
7.751
7.734
7.716
7.712
7.567
7.547
7.445
7.424
7.261
7.201
7.188
7.184
7.171
6.995
6.975
6.956
6.867
6.845
6.775
6.755
3.773
1.971
0.000
3q
1.00
0.96
1.01
1.03
4.00
1.06
1.09
4.03
2.05
6.11
6.04
f1 (ppm)
165.898
164.140
159.979
147.181
137.421
137.296
137.119
135.767
129.254
126.837
124.051
121.942
119.840
115.050
77.471
77.153
76.835
57.654
55.368
27.483
3q
f1 (ppm)

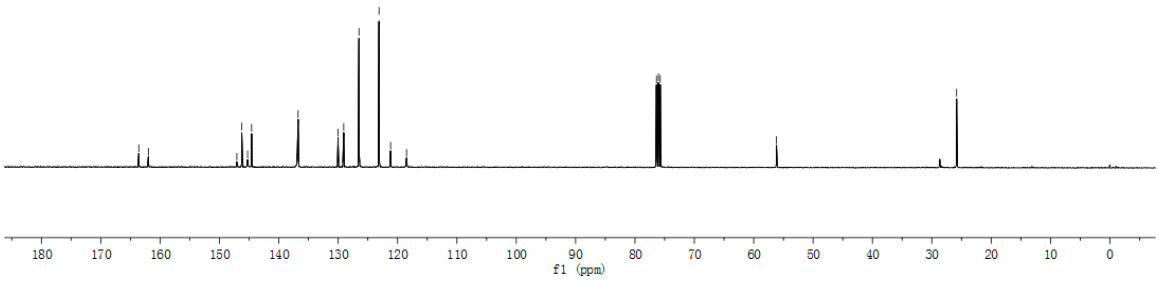

8.110
8.099
8.026
7.960
7.939
7.613
7.594
7.578
7.477
7.457
7.438
7.247
7.227
7.197
7.159
7.137
7.058
7.044
7.028
1.635
0.000

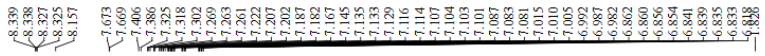

HN
O
S
S
NO2
N2O
3r

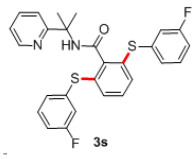

0.96
1.00
4.03
2.86
1.05
1.05
3.83
1.00
6.12
11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0 -1.5 -2.0
f1 (ppm)

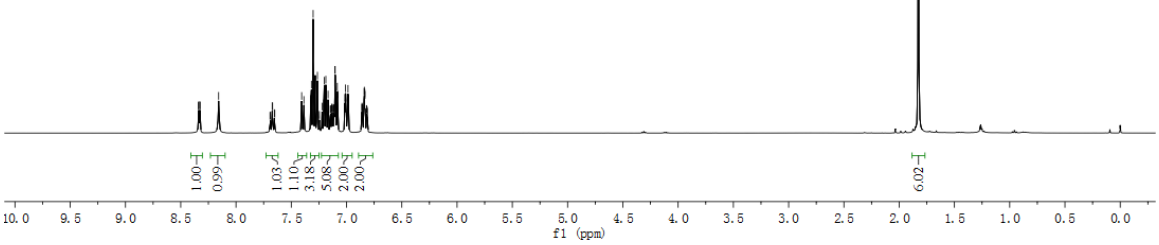

163.591
161.981
147.068
146.237
145.254
144.590
136.922
136.751
130.031
129.068
126.495
123.118
121.169
118.483
76.387
76.069
75.751
56.159
25.821

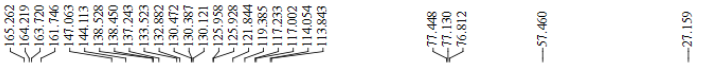

HN
O
S
S
NO2
N2O
3r

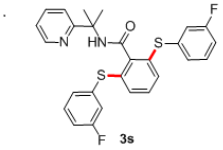

180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

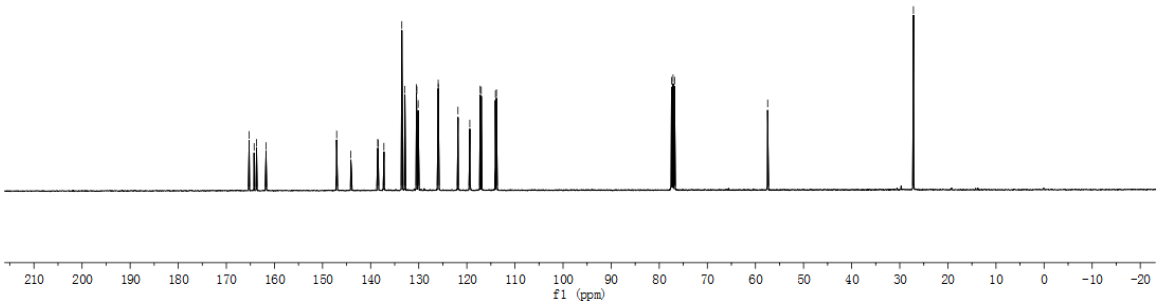


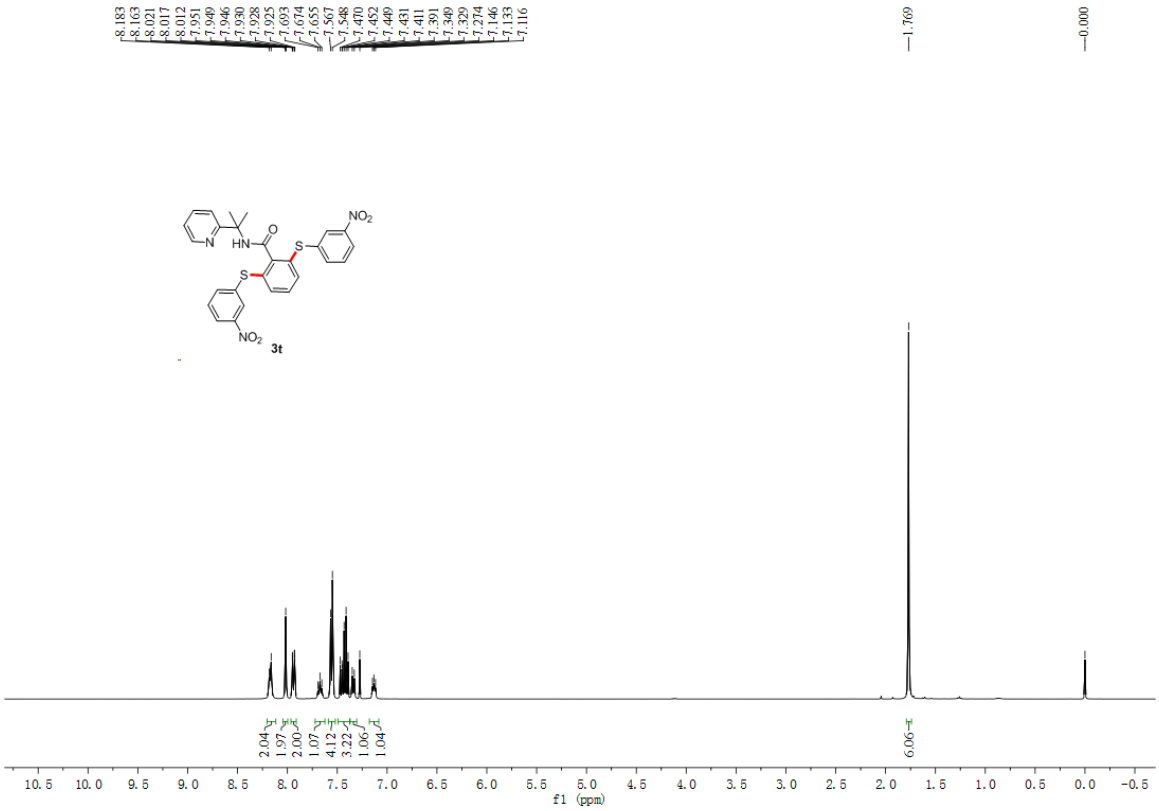

F
N
HN
O
S
S
F
3s

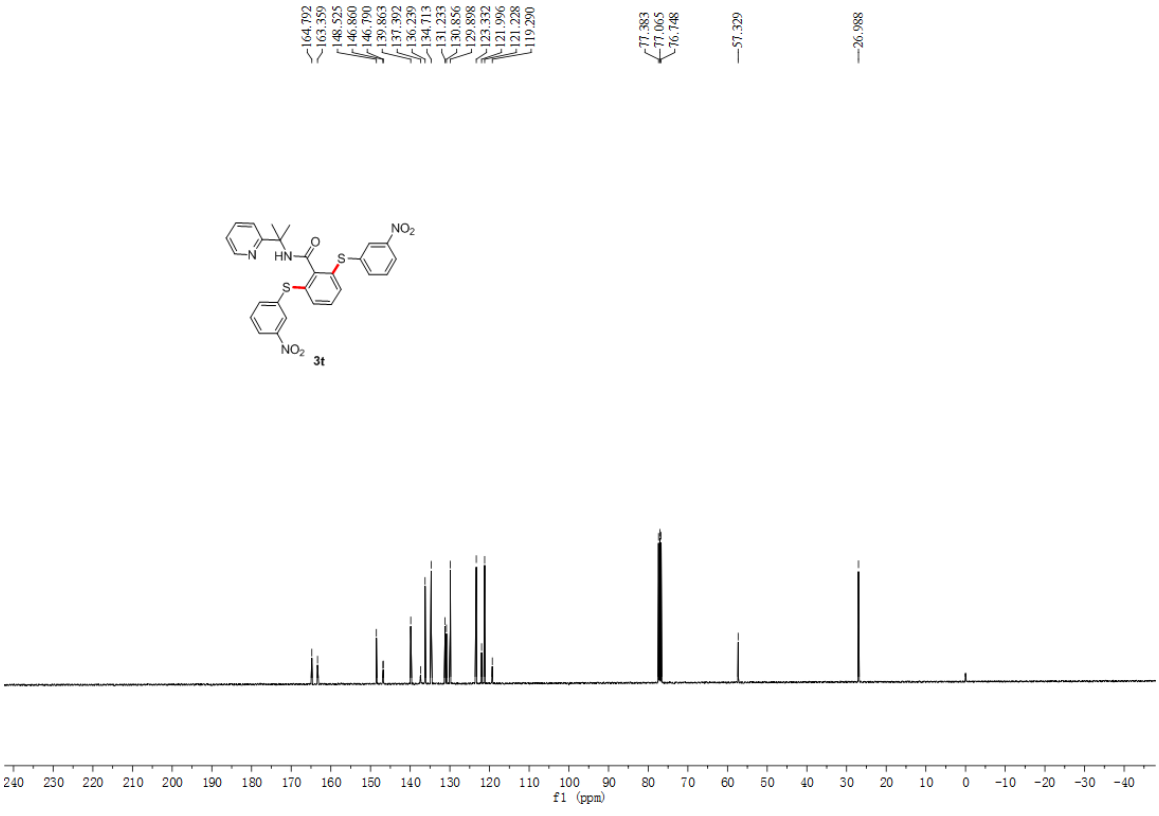

1.00
0.99
1.03
1.10
3.18
5.08
2.00
2.00
6.02
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)




F
N
HN
O
S
S
F
3s


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


8.183
8.163
8.021
8.017
8.012
7.951
7.949
7.946
7.930
7.928
7.925
7.693
7.674
7.655
7.567
7.548
7.470
7.452
7.449
7.431
7.411
7.391
7.349
7.329
7.274
7.146
7.133
7.116
1.769
0.000
NO2
HN
O
S
S
NO2
3t
2.04
1.97
2.00
1.07
4.12
3.22
1.06
1.04
6.06
f1 (ppm)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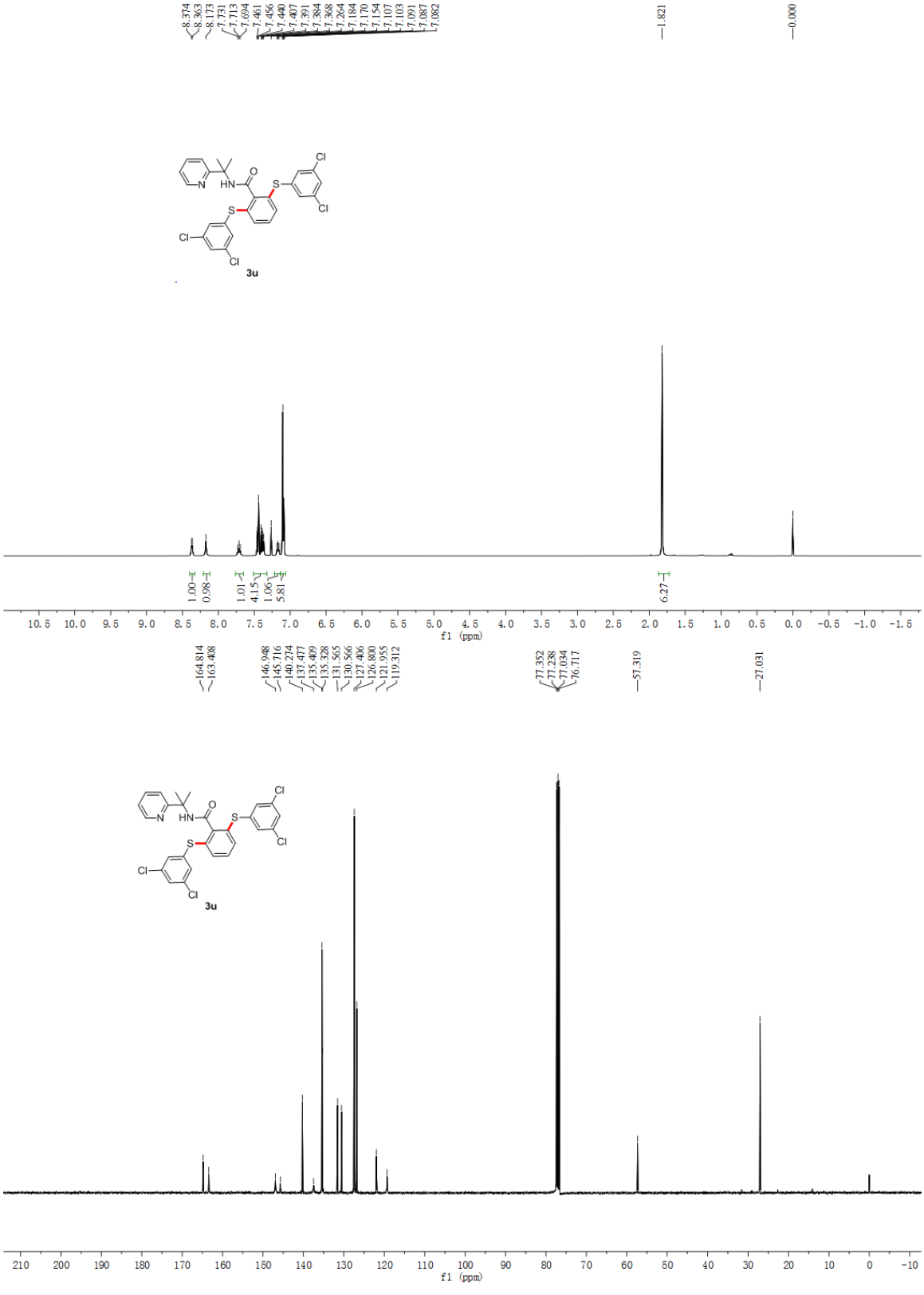
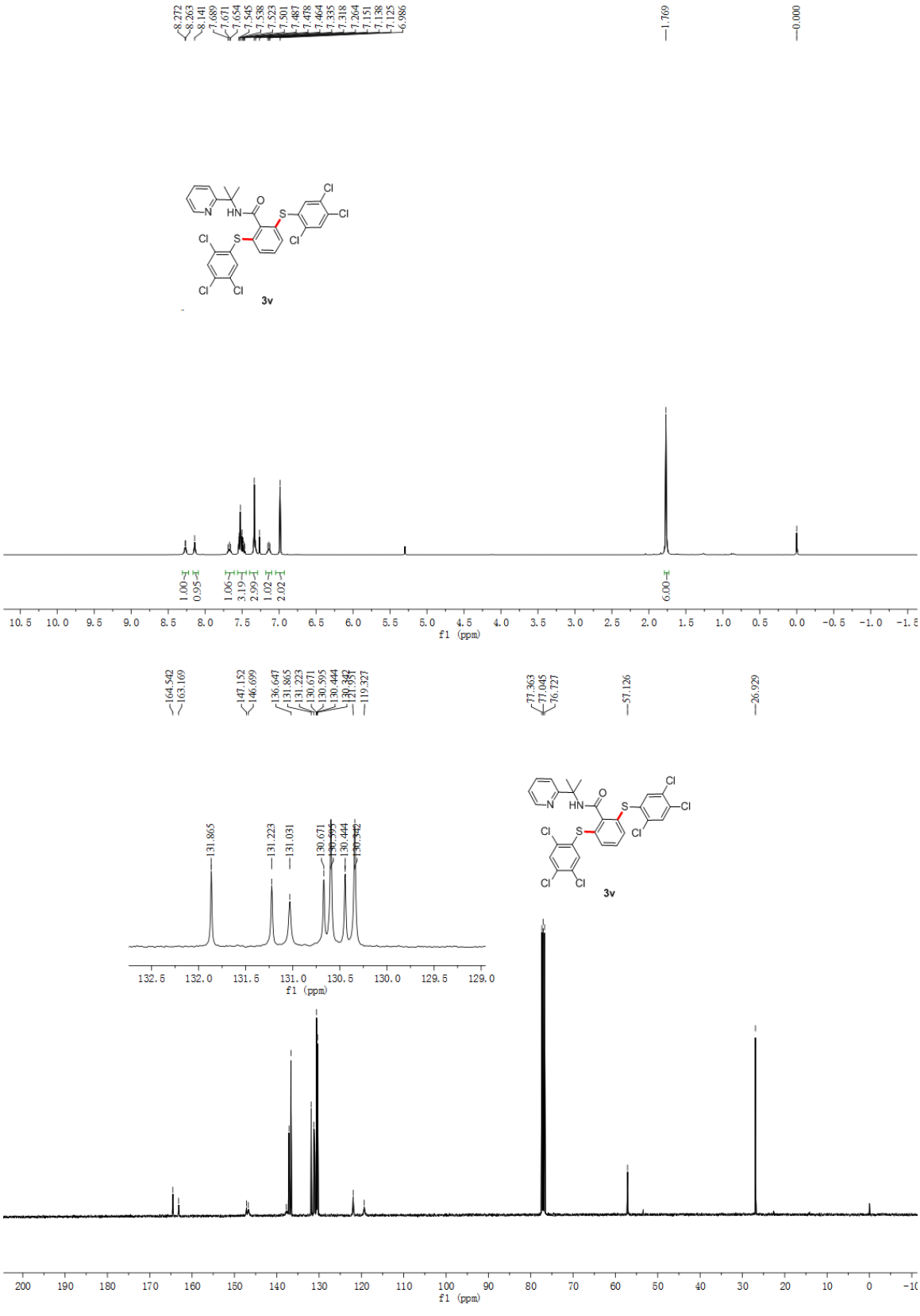
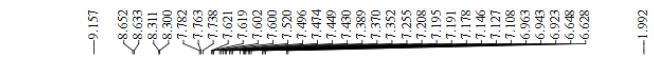
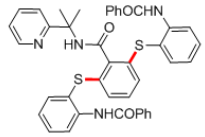
148.525
146.860
146.790
139.863
137.392
136.239
134.713
131.233
130.856
129.898
123.332
121.996
121.228
119.290
77.383
77.065
76.748
57.329
26.988
NO2
HN
O
S
S
NO2
3t
f1 (ppm)

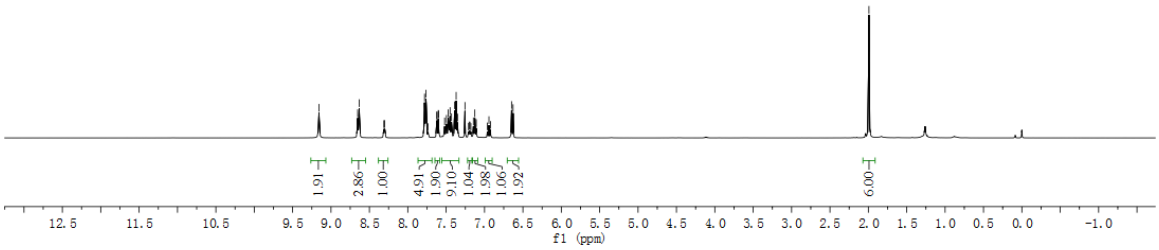

8.374
8.363
8.173
7.731
7.713
7.694
7.461
7.456
7.440
7.407
7.391
7.384
7.368
7.264
7.184
7.170
7.154
7.107
7.103
7.091
7.087
7.082
1.821
0.000
3u
1.00
0.98
1.01
4.15
1.06
5.81
6.27
f1 (ppm)
164.814
163.408
146.948
145.716
140.274
137.477
135.409
135.328
131.565
130.566
127.406
126.800
121.955
119.312
77.352
77.238
77.034
76.717
57.319
27.031
3u
f1 (ppm)

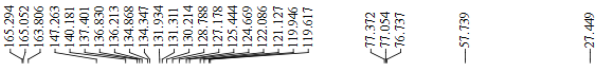

8.272
8.263
8.141
7.689
7.671
7.654
7.545
7.538
7.523
7.501
7.487
7.478
7.464
7.335
7.318
7.264
7.151
7.138
7.125
6.986
1.769
0.000
3v
1.00
0.95
1.06
3.19
2.99
1.02
2.02
6.00
f1 (ppm)
164.542
163.169
147.152
146.699
136.647
131.865
131.223
131.031
130.671
130.595
130.444
130.342
119.327
77.363
77.045
76.727
57.126
26.929
3v
131.865
131.223
131.031
130.671
130.595
130.444
130.342
f1 (ppm)
f1 (ppm)

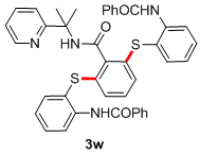

9.157
8.652
8.633
8.311
8.300
7.782
7.763
7.738
7.621
7.619
7.602
7.600
7.520
7.496
7.474
7.449
7.430
7.389
7.370
7.352
7.255
7.208
7.195
7.191
7.178
7.146
7.127
7.108
6.963
6.943
6.923
6.648
6.628
1.992


PhOCHN
HN
O
S
S
NHCOPh

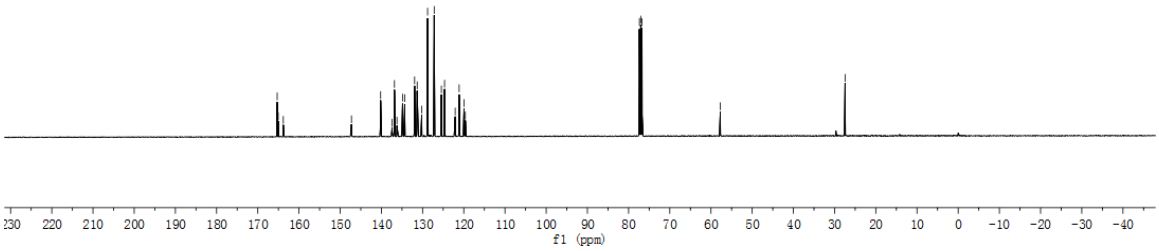
3w

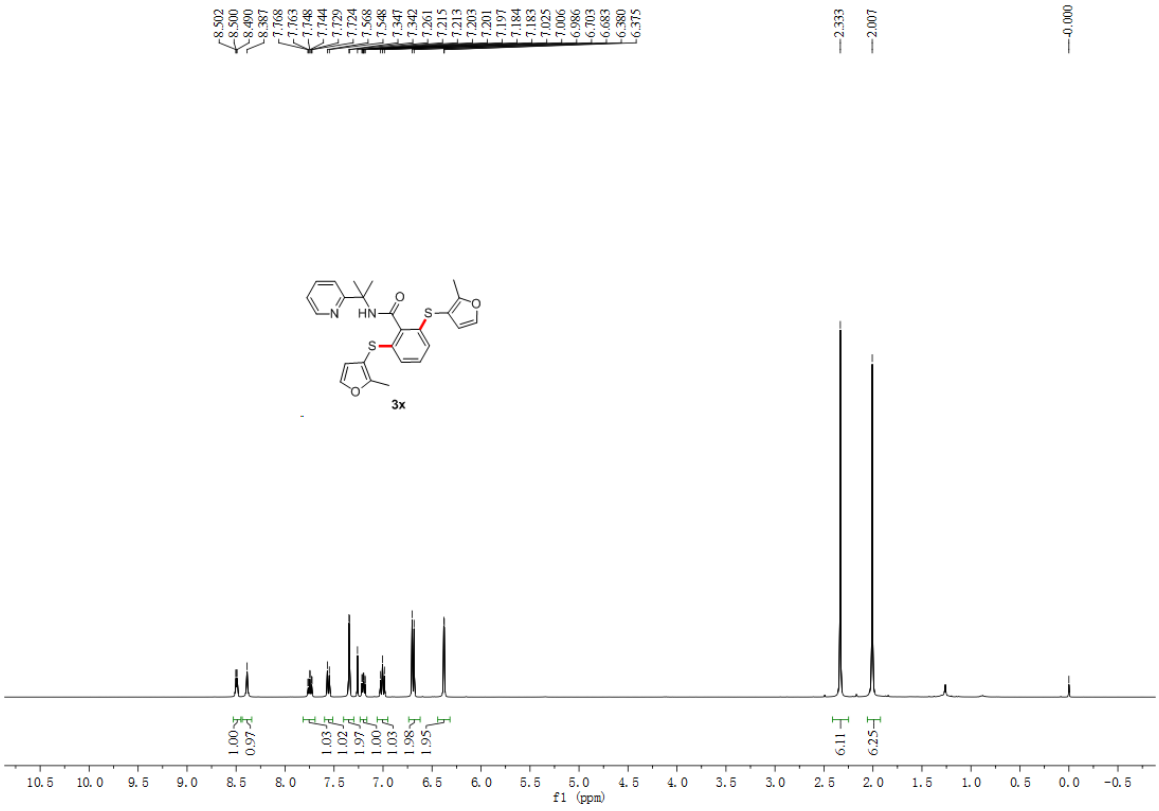

1.91
2.86
1.00
4.91
1.90
9.10
1.04
1.98
1.06
1.92
6.00
12.5
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-1.0
f1 (ppm)

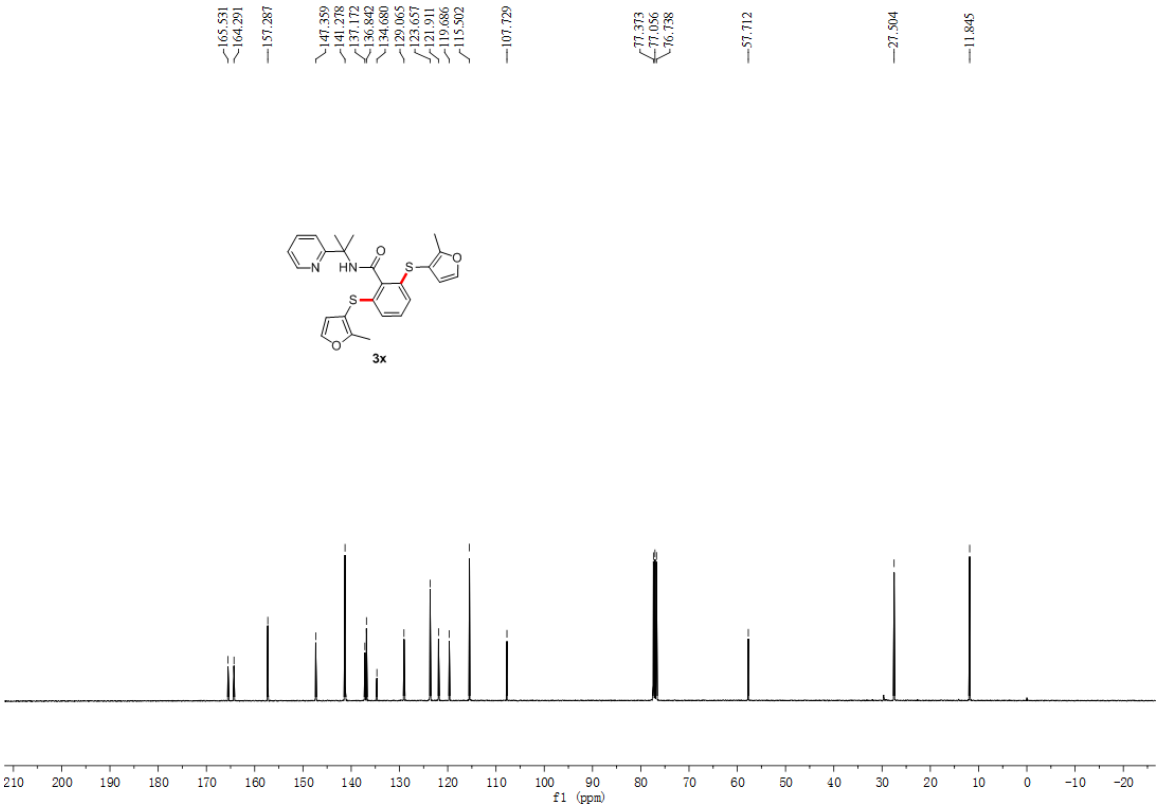

165.294
165.052
163.806
147.263
140.181
137.401
136.830
136.213
134.868
134.347
131.934
131.311
130.214
128.788
127.178
125.444
124.669
122.086
121.127
119.946
119.617
77.372
77.054
76.737
57.739
27.449

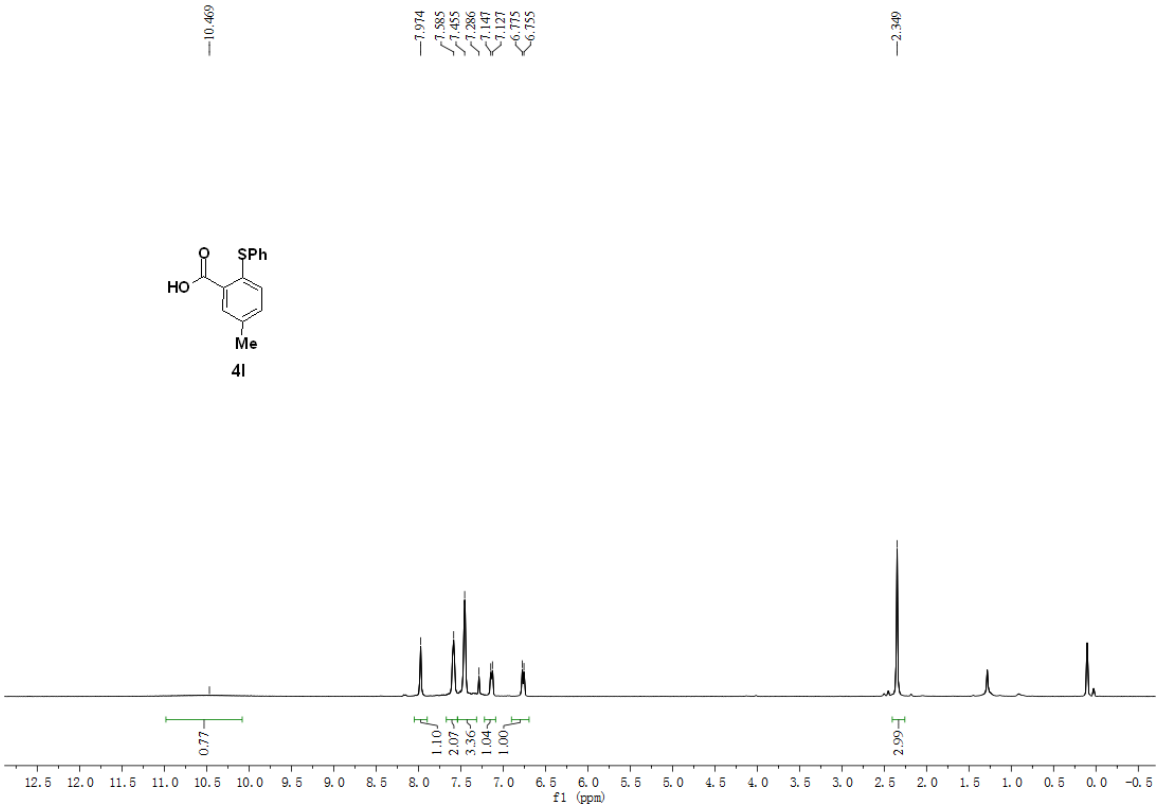

PhOCHN
HN
O
S
S
NHCOPh

3w

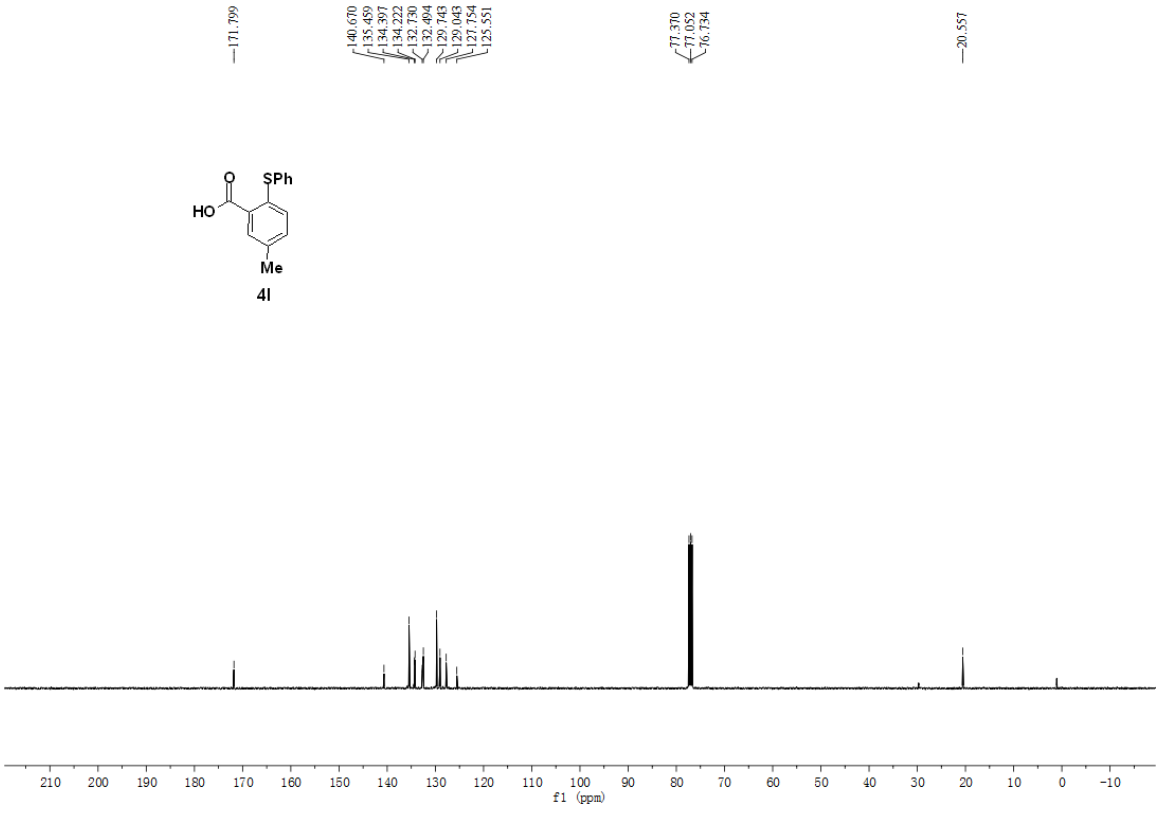

230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
f1 (ppm)


8.502
8.500
8.490
8.387
7.768
7.763
7.748
7.744
7.729
7.724
7.568
7.548
7.347
7.342
7.261
7.215
7.213
7.203
7.201
7.197
7.184
7.183
7.025
7.006
6.986
6.703
6.683
6.380
6.375
2.333
2.007
0.000
3x
1.00
0.97
1.03
1.02
1.97
1.00
1.03
1.98
1.95
6.11
6.25
f1 (ppm)


165.531
164.291
157.287
147.359
141.278
137.172
136.842
134.680
129.065
123.657
121.911
119.686
115.502
107.729
77.373
77.056
76.738
57.712
27.504
11.845
3x
f1 (ppm)


10.469
7.974
7.585
7.455
7.286
7.147
7.127
6.775
6.755
2.349
O
SPh
HO
Me
0.77
1.10
2.07
3.36
1.04
1.00
2.99
12.5 12.0 11.5 11.0 10.5 10.0 9.5 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 -0.5
f1 (ppm)

4l


171.799
140.670
135.459
134.397
134.222
132.730
132.494
129.743
129.043
127.754
125.551
77.370
77.052
76.734
20.557
O
SPh
HO
Me
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

4l