SUPPORTING INFORMATION

Self-catalytic photochemical sulfonylation of phenothiazines

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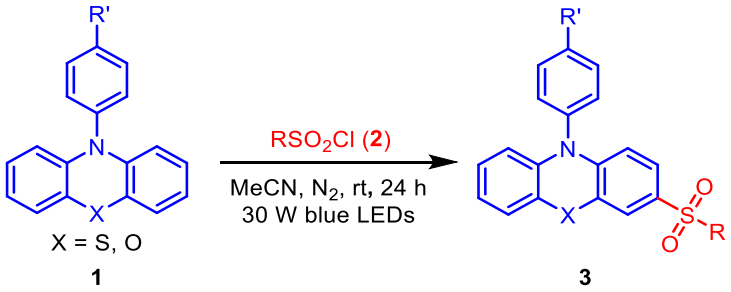
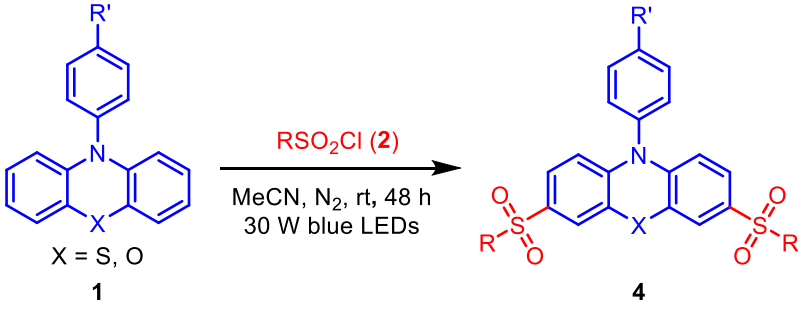
1. General experimental details

All reactions were maintained under a nitrogen atmosphere unless otherwise stated. Commercially available reagents were used without further purification. Infrared (FT-IR) spectra were recorded on a BRUKER VERTEX 70, νmax in cm^{-1}. ^{1}H-NMR spectra were recorded on a BRUKER AVANCE III HD (400 MHz) spectrometer. Chemical shifts are reported in ppm from tetramethylsilane with the solvent resonance as internal standard ($CDCl_3$: δ 7.26). Data are reported as follows: chemical shift, multiplicity (s = singlet, d = doublet, t = triplet, q = quadruplet, br = broad, m = multiplet), coupling constants (Hz) and integration. ^{13}C-NMR spectra were recorded on a BRUKER AVANCE III HD (100 MHz) spectrometer with complete proton decoupling. Chemical shifts are reported in ppm from tetramethylsilane with the solvent resonance as the internal standard ($CDCl_3$: δ 77.16). ^{19}F-NMR spectra were recorded on a BRUKER AVANCE III HD (377 MHz) spectrometer. Mass spectra were measured with an Agilent Technologies 6120 Quadrupole LC/MS. High resolution mass spectrometry (HRMS) were measured with a GCT PremierTM and BRUKER micrOTF-Q III. Melting points were measured using INESA WRR and values are uncorrected. Flash column chromatography was performed using 300-400 mesh silica gel with the indicated solvent system.

2. General procedures for mono/di-sulfonylation of phenothiazines

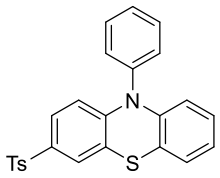


Mono-sulfonylation of phenothiazines: PTH (0.2 mmol, 55.1 mg) and RSO_2Cl (0.2 mmol) were loaded in a flask, which was subjected to evacuation/ flushing with N_2 for 3 times. MeCN (1.0 mL) was added to the mixture via syringe, which was irradiated by 30 W blue LEDs (450 nm wavelength) and stirred at rt for 24 h. The mixture was concentrated in vacuo, and purified by flash column chromatography on silica gel (eluent: ethyl acetate/petroleum ether) to give the corresponding products.

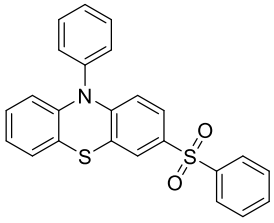


Di-sulfonylation of phenothiazines: PTH (0.2 mmol, 55.1 mg), RSO_2Cl (0.8 mmol) were loaded in a flask, which was subjected to evacuation/ flushing with N_2 for 3 times. MeCN (1.0 mL) was added to the mixture via syringe, which was irradiated by 30 W blue LEDs (450 nm wavelength) and stirred at rt for 48 h. The mixture was concentrated in vacuo, and purified by flash column chromatography on silica gel (eluent: ethyl acetate/petroleum ether) to give the corresponding products.

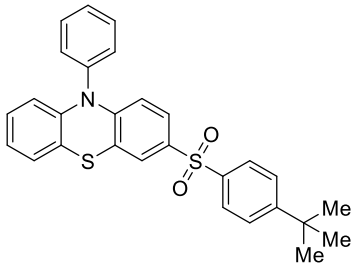
3. Characterization of new compounds



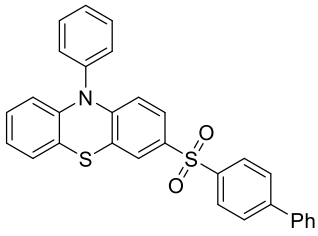
3a: 89% yield, 76.3 mg, yellow solid, m.p. 88-89 °C. Purification by flash column chromatography (eluent: EtOAc/Petroleum ether = 1/10). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.74 (d, *J* = 8.0 Hz, 2H), 7.66-7.56 (m, 2H), 7.54-7.48 (m, 1H), 7.48-7.44 (m, 1H) 7.35-7.29 (m, 3H), 7.26-7.22 (m, 2H) 6.95-6.89 (m, 1H), 6.85-6.77 (m, 2H), 6.15-6.04 (m, 2H), 2.37 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 148.2, 143.9, 142.8, 139.8, 139.2, 134.8, 131.2, 130.7, 129.9, 129.1, 127.4, 127.3, 126.8, 126.7, 125.7, 123.7, 120.7, 118.7, 116.4, 115.1, 21.6. FT-IR: ν (cm^{-1}) 3061, 2920, 1585, 1458, 1258, 1018, 987, 937. HRMS [ESI] calcd for $C_{25}H_{19}NNaO_2S_2^+$ $[M+Na]^+$ 452.0749, found 452.0745.



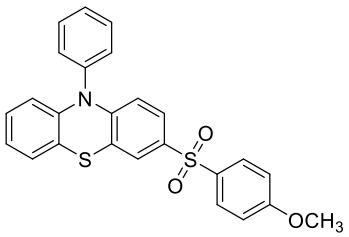
3b: 96% yield, 79.7 mg, yellow solid, m.p. 94-95 °C. Purification by flash column chromatography (eluent: EtOAc/Petroleum ether = 1/20). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.91-7.84 (m, 2H), 7.66-7.58 (m, 2H), 7.56-7.43 (m, 5H), 7.37-7.31 (m, 3H), 6.98-6.91 (m, 1H), 6.86-6.77 (m, 2H), 6.15-6.06 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 148.4, 142.7, 142.2, 139.7, 134.3, 132.9, 131.2, 130.7, 129.2, 129.1, 127.3, 127.3, 127.0, 126.7, 125.8, 123.7, 120.8, 118.7, 116.4, 115.1. FT-IR: ν (cm^{-1}) 3060, 2920, 2850, 1585, 1485, 1315, 1258, 811, 726, 686. HRMS [ESI] calcd for $C_{24}H_{17}NNaO_2S_2^+$ $[M+Na]^+$ 438.0593, found 438.0591.



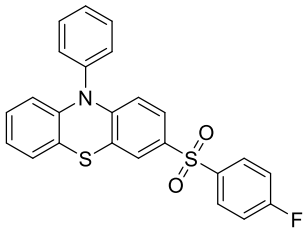
3c: 80% yield, 75.3 mg, yellow solid, m.p. 258-259 °C. Purification by flash column chromatography (eluent: EtOAc/Petroleum ether = 1/30-1/10). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.81-7.76 (m, 2H), 7.64-7.59 (m, 2H), 7.55-7.50 (m, 1H), 7.50-7.47 (m, 2H), 7.47-7.44 (m, 1H), 7.36-7.30 (m, 3H), 6.97-6.92 (m, 1H), 6.85-6.79 (m, 2H), 6.12 (d, *J* = 8.8 Hz, 1H), 6.11-6.07 (m, 1H), 1.30 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.8, 148.2, 142.8, 139.8, 139.1, 134.7, 131.2, 130.7, 129.1, 127.3, 127.2, 126.9, 126.7, 126.3, 125.8, 123.7, 120.7, 118.7, 116.4, 115.1, 35.1, 31.0. FT-IR: ν (cm^{-1}) 2954, 2861, 2257, 1927, 1586, 1561, 1390, 1322, 1247, 1157, 1121, 724, 663, 629. HRMS [ESI] calcd for $C_{28}H_{26}NO_2S_2^+$ $[M+H]^+$ 472.1399, found 472.1390.



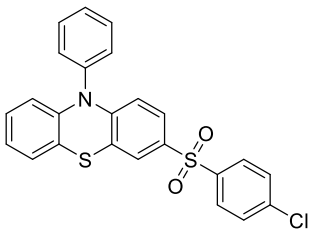
3d: 81% yield, 79.5 mg, yellow solid, m.p. 96-97 °C. Purification by flash column chromatography (eluent: EtOAc/Petroleum ether = 1/15-1/10). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.94 (d, *J* = 8.4 Hz, 2H), 7.69-7.65 (m, 2H), 7.63-7.59 (m, 2H), 7.57-7.52 (m, 4H), 7.48-7.43 (m, 2H), 7.42-7.39 (m, 1H), 7.39-7.36 (m, 1H), 7.34-7.33 (m, 1H), 7.32-7.30 (m, 1H), 6.97-6.93 (m, 1H), 6.84-6.81 (m, 2H), 6.14 (d, *J* = 8.8 Hz, 1H), 6.12-6.09 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 148.4, 145.9, 142.7, 140.7, 139.7, 139.3, 134.5, 131.2, 130.7, 129.1, 129.1, 128.5, 127.9, 127.9, 127.4, 127.3, 127.0, 126.7, 125.8, 123.7, 120.8, 118.7, 116.4, 115.1. FT-IR: ν (cm^{-1}) 3029, 2946, 1586, 1492, 1390, 1115, 902. HRMS [ESI] calcd for $C_{30}H_{22}NO_2S_2^+$ $[M+H]^+$ 492.1086, found 492.1085.



3e: 88% yield, 78.6 mg, yellow solid, m.p. 163-164 °C. Purification by flash column chromatography (eluent: EtOAc/Petroleum ether = 1/50). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.82-7.76 (m, 2H), 7.65-7.58 (m, 2H), 7.54-7.48 (m, 1H), 7.46 (d, *J* = 2.4 Hz, 1H), 7.34-7.28 (m, 3H), 6.97-6.89 (m, 3H), 6.85-6.77 (m, 2H), 6.14-6.07 (m, 2H), 3.82 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 163.2, 148.1, 142.8, 139.8, 135.2, 133.7, 131.2, 130.7, 129.5, 129.1, 127.3, 126.7, 126.6, 125.5, 123.6, 120.7, 118.7, 116.3, 115.1, 114.5, 55.7. FT-IR: ν (cm^{-1}) 3100, 2972, 2929, 2845, 1771, 1562, 1439, 1079, 835. HRMS [ESI] calcd for $C_{25}H_{20}NO_3S_2^+$ $[M+H]^+$ 446.0879, found 446.0881

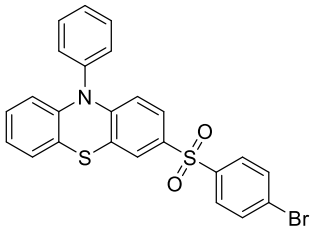


3f: 85% yield, 73.4 mg, yellow solid, m.p. 88-89 °C. Purification by flash column chromatography (eluent: EtOAc/Petroleum ether = 1/20). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.92-7.84 (m, 2H), 7.66-7.58 (m, 2H), 7.56-7.49 (m, 1H), 7.46 (d, *J* = 2.0 Hz, 1H), 7.36-7.28 (m, 3H), 7.18-7.10 (m, 2H), 6.98-6.91 (m, 1H), 6.86-6.78 (m, 2H), 6,15-6.07 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 165.3 (d, J_{C-F} = 253.8 Hz), 148.5, 142.7, 139.7 138.3 (d, J_{C-F} = 3.1 Hz), 134.1, 131.2, 130.7, 130.1 (d, J_{C-F} = 9.4 Hz), 129.2, 127.4, 126.9, 126.7, 125.7, 123.8, 120.9, 118.6, 116.5 (d, J_{C-F} = 18.6 Hz), 116.4, 115.1; ^{19}F NMR (377 MHz, $CDCl_3$) δ -104.8 (s). FT-IR: ν (cm^{-1}) 3061, 2922, 2851, 1586, 1491, 1258, 1077, 1024, 901, 813, 746, 650. HRMS [ESI] calcd for $C_{24}H_{17}FNO_2S_2^+$ $[M+H]^+$ 434.0679, found 434.0674.

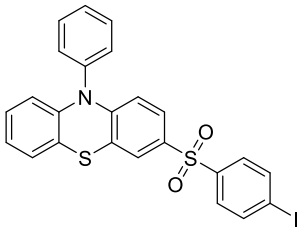


3g: 70% yield, 63.1 mg, yellow solid, m.p. 189-199 °C. Purification by flash column chromatography (eluent: EtOAc/Petroleum ether = 1/50). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.83-7.77 (m, 2H), 7.66-7.58 (m, 2H), 7.56-7.49 (m, 1H), 7.48-7.41 (m, 3H), 7.35-7.28 (m, 3H), 6.97-6.89(m, 1H), 6.86-6.78 (m, 2H), 6.14-6.05 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 148.6, 142.6, 140.7, 139.6, 139.5, 133.8, 131.2, 130.7, 129.5, 129.2, 128.8,

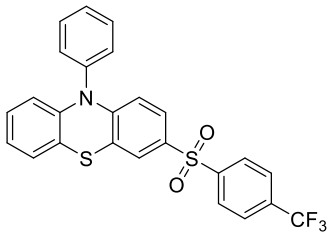
127.4, 127.0, 126.7, 125.7, 123.8, 120.9, 118.6, 116.4, 115.1. FT-IR: ν (cm^{-1}) 3057, 2924, 2853, 1584, 1491, 1461, 1440, 1309, 901, 751, 707, 633. HRMS [ESI] calcd for $C_{24}H_{17}ClNO_2S_2^+$ $[M+H]^+$ 450.0384, found 450.0391.



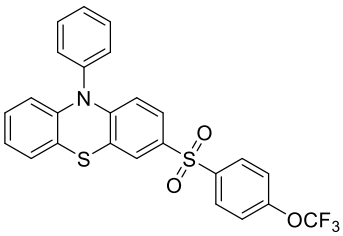
3h: 23% yield, 22.6 mg, yellow solid, m.p. 203-204 °C. Purification by flash column chromatography (eluent: EtOAc/Petroleum ether = 1/50). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.74-7.70 (m, 2H), 7.65-7.58 (m, 4H), 7.56-7.50 (m, 1H), 7.45 (d, *J* = 2.0 Hz, 1H), 7.34-7.28 (m, 3H), 6.97-6.93 (m, 1H), 6.85-6.79 (m, 2H), 6.13-6.06 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 148.6, 142.6, 141.3, 139.7, 133.7, 132.5, 131.2, 130.7, 129.2, 128.8, 128.1, 127.4, 127.0, 126.7, 125.7, 123.8, 120.9, 118.6, 116.4, 115.1. FT-IR: ν (cm^{-1}) 3056, 2920, 2851, 1562, 1490, 1440, 1388, 1308, 1245, 1150, 930, 902, 751, 724, 707. HRMS [ESI] calcd for $C_{24}H_{17}BrNO_2S_2^+$ $[M+H]^+$ 493.9879, found 493.9870.



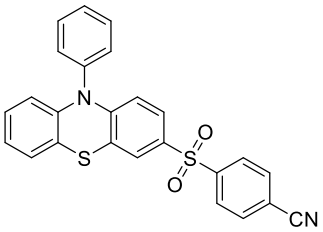
3i: 50% yield, 53.2 mg, yellow solid, m.p. 210-211 °C. Purification by flash column chromatography (eluent: EtOAc/Petroleum ether = 1/50). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.84-7.77 (m, 2H), 7.66-7.59 (m, 2H), 7.59-7.55 (m, 2H), 7.54-7.49 (m, 1H), 7.47-7.43 (m, 1H), 7.35-7.27 (m, 3H), 6.97-6.89 (m, 1H), 6.86-6.78 (m, 2H), 6.14-6.04 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 148.6, 142.6, 141.9, 139.6, 138.5, 133.7, 131.2, 130.7, 129.2, 128.7, 127.4, 127.0, 126.7, 125.7, 123.8, 120.9, 118.6, 116.4, 115.1, 100.6. FT-IR: ν (cm^{-1}) 2956, 2922, 2852, 1584, 1564, 1460, 1440, 1290, 901, 677. HRMS [ESI] calcd for $C_{24}H_{17}INO_2S_2^+$ $[M+H]^+$ 541.9740, found 541.9738.



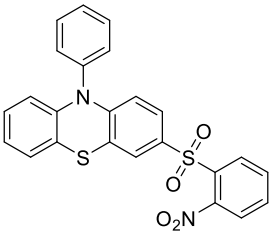
3j: 67% yield, 64.7 mg, yellow solid, m.p 142-143 °C. Purification by flash column chromatography (eluent: EtOAc/Petroleum ether = 1/20). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.99 (d, *J* = 8.4 Hz, 2H), 7.74 (d, *J* = 8.0 Hz, 2H), 7.66-7.60 (m, 2H), 7.56-7.51 (m, 1H), 7.48 (d, *J* = 2.4 Hz, 1H), 7.35-7.30 (m, 3H), 6.98-6.92 (m, 1H), 6.87-6.79 (m, 2H), 6.13 (d, *J* = 8.8 Hz, 1H), 6.11-6.07 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 148.9, 145.8, 142.5, 139.6, 134.5 (q, J_{C-F} = 32.9 Hz), 133.1, 131.3, 130.7, 129.2, 127.8, 127.4, 127.3, 126.7, 126.4 (q, J_{C-F} = 3.8 Hz), 125.9, 123.9, 123.2 (q, J_{C-F} = 271.1 Hz), 121.1, 118.5, 116.5, 115.1; ^{19}F NMR (377 MHz, $CDCl_3$) δ -63.2 (s). FT-IR: ν (cm^{-1}) 3062, 2921, 1586, 1492, 1460, 1402, 1153, 1115, 902, 835, 746, 669. HRMS [ESI] calcd for $C_{25}H_{16}F_3NNaO_2S_2^+$ $[M+Na]^+$ 506.0467, found 506.0478.



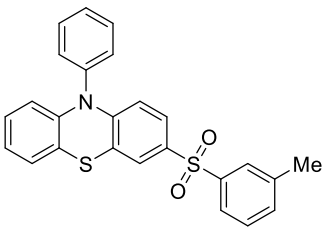
3k: 86% yield, 85.5 mg, yellow solid, m.p. 82-83 °C. Purification by flash column chromatography (eluent: EtOAc/Petroleum ether = 1/20). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.95-7.90 (m, 2H), 7.65-7.60 (m, 2H), 7.55-7.50 (m, 1H), 7.48 (d, *J* = 2.0 Hz, 1H), 7.35-7.27 (m, 5H), 6.97-6.92 (m, 1H), 6.87-6.79 (m, 2H), 6.14 (d, *J* = 8.8 Hz, 1H), 6.12-6.08 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 152.3 (q, $J_{C\text{-}F}$ = 1.9 Hz), 148.7, 142.6, 140.6, 139.7, 133.6, 131.3, 130.7, 129.5, 129.2, 127.4, 127.1, 126.7, 125.8, 123.9, 121.1, 121.0, 120.2 (q, $J_{C\text{-}F}$ = 257.9 Hz), 118.6, 116.5, 115.2; ^{19}F NMR (377 MHz, $CDCl_3$) δ -57.7 (s). FT-IR: ν (cm^{-1}) 3058, 2949, 2856, 1586, 1440, 1209, 1115, 812. HRMS [ESI] calcd for $C_{32}H_{25}NKO_4S_3^+$ $[M+K]^+$ 538.0155, found 538.0142.



3l: 51% yield, 44.9 mg, yellow solid, m.p. 176-177 °C. Purification by flash column chromatography (eluent: EtOAc/Petroleum ether = 1/20). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.00-7.94 (m, 2H), 7.79-7.73 (m, 2H), 7.67-7.60 (m, 2H), 7.56-7.51 (m, 1H), 7.46 (d, *J* = 2.4 Hz, 1H), 7.35-7.29 (m, 3H), 6.97-6.92 (m, 1H), 6.87-6.79 (m, 2H), 6.13 (d, *J* = 8.8 Hz, 1H), 6.12-6.07 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 149.1, 146.5, 142.4, 139.5, 133.0, 132.5, 131.3, 130.6, 129.3, 127.9, 127.5, 127.4, 126.8, 126.0, 124.0, 121.2, 118.4, 117.3, 116.6, 116.5, 115.2. FT-IR: ν (cm^{-1}) 3096, 3059, 2228, 1583, 1491, 1389, 1314, 1248, 1117, 900, 816, 767. HRMS [ESI] calcd for $C_{25}H_{16}N_2NaO_2S_2^+$ $[M+Na]^+$ 463.0545, found 463.0546.

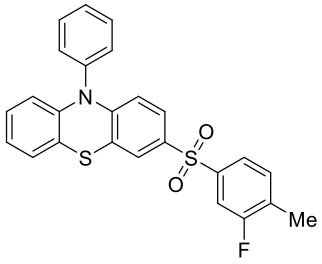


3m: 31% yield, 28.9 mg, yellow solid, m.p. 88-89 °C. Purification by flash column chromatography (eluent: Acetone/Petroleum ether = 1/10). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.25-8.20 (m, 1H), 7.75-7.60 (m, 5H), 7.57-7.51 (m, 1H), 7.50 (d, *J* = 2.4 Hz, 1H), 7.41 (dd, *J* = 4.8, 2.4 Hz, 1H), 7.37-7.30 (m, 2H), 6.98-6.90 (m, 1H), 6.87-6.78 (m, 2H), 6.17 (d, *J* = 9.2 Hz, 1H), 6.13-6.05 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 148.9, 148.3, 142.5, 139.6, 135.1, 134.2, 132.7, 132.4, 131.3, 130.7, 129.2, 128.2, 127.4, 126.7, 126.5, 124.6, 123.9, 120.5, 118.7, 116.5, 114.7. FT-IR: ν (cm^{-1}) 3021, 2947, 1585, 1562, 1540, 1492, 1367, 1314, 1287, 1258, 1154, 697, 660, 649. HRMS [ESI] calcd for $C_{24}H_{17}N_2O_4S_2^+$ $[M+H]^+$ 461.0624 found 461.0630.

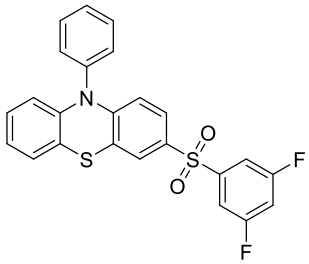


3n: 96% yield, 82.4 mg, yellow solid, m.p. 84-85 °C. Purification by flash column chromatography (eluent: EtOAc/Petroleum ether = 1/20). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.70-7.65 (m, 2H), 7.64-7.59 (m, 2H), 7.55-7.47 (m, 2H), 7.38-7.30 (m, 5H), 6.97-6.92 (m, 1H), 6.85-6.77 (m, 2H), 6.15-6.08 (m, 2H), 2.38 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 148.3, 142.8, 141.9, 139.7, 139.5, 134.5, 133.8, 131.2, 130.7, 129.1,

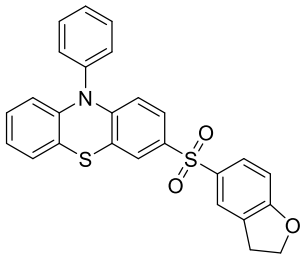
127.6, 127.3, 127.0, 126.7, 125.8, 124.5, 123.7, 120.7, 118.7, 116.4, 115.1, 21.4. FT-IR: ν (cm^{-1}) 3058, 2949, 2856, 1585, 1492, 1440, 1390, 1258, 902, 811, 724, 631. HRMS [ESI] calcd for $C_{25}H_{19}NNaO_2S_2^+$ $[M+Na]^+$ 452.0749, found 452.0750.



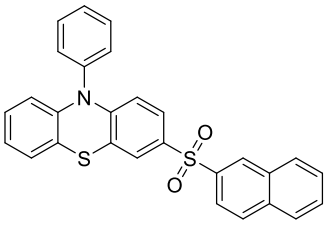
3o: 89% yield, 79.3 mg, yellow solid, m.p. 86-87 °C. Purification by flash column chromatography (eluent: EtOAc/Petroleum ether = 1/25-1/20). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.66-7.59 (m, 2H), 7.58-7.47 (m, 3H), 7.46 (d, *J* = 2.0 Hz, 1H), 7.36-7.26 (m, 4H), 6.97-6.91 (m, 1H), 6.85-6.78 (m, 2H), 6.12 (d, *J* = 4.8 Hz, 1H), 6.11-6.07 (m, 1H), 2.29 (d, *J* = 1.6 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 160.9 (d, J_{C-F} = 248.8 Hz), 148.5, 142.7, 141.4 (d, J_{C-F} = 6.5 Hz), 139.7, 134.0, 132.3 (d, J_{C-F} = 4.9 Hz), 131.2, 131.0 (d, J_{C-F} = 17.3 Hz), 130.7, 129.2, 127.4, 127.0, 126.7, 125.8, 123.8, 122.8 (d, J_{C-F} = 3.6 Hz), 120.9, 118.6, 116.4, 115.1, 114.2 (d, J_{C-F} = 25.2 Hz), 14.8 (d, J_{C-F} = 3.5 Hz); ^{19}F NMR (377 MHz, $CDCl_3$) δ -113.5 (s). FT-IR: ν (cm^{-1}) 3061, 2924, 1585, 1562, 1490, 1458, 1440, 1286, 1228, 1189, 1149, 1129, 746, 708, 681, 653. HRMS [ESI] calcd for $C_{25}H_{18}FNNaO_2S_2^+$ $[M+Na]^+$ 470.0655, found 470.0651.



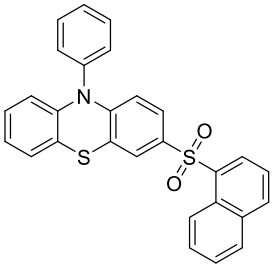
3p: 96% yield, 86.6 mg, yellow solid, m.p. 74-75 °C. Purification by flash column chromatography (eluent: EtOAc/Petroleum ether = 1/20). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.67-7.61 (m, 2H), 7.56-7.51 (m, 1H), 7.46 (d, *J* = 2.0 Hz, 1H), 7.43-7.37 (m, 2H), 7.36-7.29 (m, 3H), 7.01-6.92 (m, 2H), 6.87-6.80 (m, 2H), 6.14 (d, *J* = 8.8 Hz, 1H), 6.13-6.07 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.9 (dd, J_{C-F} = 253.5, 4.1 Hz), 149.0, 145.6 (t, J_{C-F} = 7.8 Hz), 142.5, 139.6, 132.6, 131.3, 130.6, 129.3, 127.4, 127.4, 126.8, 125.9, 124.0, 121.1, 118.5, 116.5, 115.2, 110.8 (dd, J_{C-F} = 8.3, 19.5 Hz), 108.5 (t, J_{C-F} = 24.9 Hz); ^{19}F NMR (377 MHz, $CDCl_3$) δ -105.2 (s). FT-IR: ν (cm^{-1}) 3083, 2927, 1600, 1491, 1390, 1152, 985. HRMS [ESI] calcd for $C_{24}H_{15}F_2NNaO_2S_2^+$ $[M+Na]^+$ 474.0404, found 474.0414.



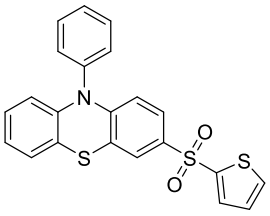
3q: 92% yield, 84.6 mg, yellow solid, m.p. 206-207 °C. Purification by flash column chromatography (eluent: EtOAc/Petroleum ether = 1/15-1/10). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.69-7.65 (m, 2H) 7.64-7.59 (m, 2H), 7.54-7.49 (m, 1H), 7.46 (d, *J* = 2.0 Hz, 1H), 7.35-7.28 (m, 3H), 6.97-6.91 (m, 1H), 6.85-6.76 (m, 3H), 6.14-6.07 (m, 2H), 4.62 (t, *J* = 8.8 Hz, 2H), 3.21 (t, *J* = 8.8 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 164.1, 148.0, 142.8, 139.8, 135.4, 133.7, 131.2, 130.7, 129.1, 129.0, 128.6, 127.3, 126.7, 126.6, 125.5, 124.6, 123.6, 120.7, 118.7, 116.3, 115.1, 109.7, 72.4, 29.0. FT-IR: ν (cm^{-1}) 3062, 2845, 1585, 1491, 1303, 1285, 1147, 980. HRMS [ESI] calcd for $C_{26}H_{20}NO_3S_2^+$ $[M+H]^+$ 458.0879, found 458.0876.



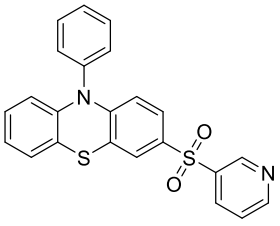
3r: 84% yield, 78.2 mg, yellow solid, m.p. 107-108 °C. Purification by flash column chromatography (eluent: EtOAc/Petroleum ether = 1/20-1/10). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.50 (s, 1H), 7.94 (d, *J* = 8.4 Hz, 1H), 7.89 (d, *J* = 8.8 Hz, 1H), 7.84 (d, *J* = 7.6 Hz, 1H), 7.80 (dd, *J* = 8.4, 0.8 Hz, 1H), 7.64-7.54 (m, 5H), 7.53-7.46 (m, 1H), 7.40 (dd, *J* = 8.8, 2.0 Hz, 1H), 7.29 (d, *J* = 7.2 Hz, 2H), 6.96-6.90 (m, 1H), 6.84-6.77 (m, 2H), 6.12 (d, *J* = 8.8 Hz, 1H), 6.10-6.03 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 148.4, 142.7, 139.7, 139.0, 134.9, 134.4, 132.3, 131.2, 130.7, 129.6, 129.4, 129.1, 129.0, 128.6, 127.9, 127.6, 127.3, 127.1, 126.7, 125.8, 123.7, 122.5, 120.8, 118.7, 116.4, 115.1. FT-IR: ν (cm^{-1}) 2955, 2920, 2851, 1723, 1645, 1585, 1492, 1388, 1131, 1068, 680, 648. HRMS [ESI] calcd for $C_{28}H_{19}NNaO_2S_2^+$ $[M+Na]^+$ 488.0749, found 488.0741.



3s: 76% yield, 71.2 mg, yellow solid, m.p. 136-137 °C. Purification by flash column chromatography (eluent: EtOAc/Petroleum ether = 1/20-1/10). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.63 (d, *J* = 8.4 Hz, 1H), 8.41 (d, *J* = 7.6 Hz, 1H), 8.06 (d, *J* = 8.0 Hz, 1H), 7.89 (d, *J* = 8.0 Hz, 1H), 7.63-7.47 (m, 7H), 7.39 (dd, *J* = 8.8, 3.0 Hz, 1H), 7.32-7.27 (m, 2H), 6.95-6.88 (m, 1H), 6.84-6.76 (m, 2H), 6.12-6.03 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 148.2, 142.7, 139.7, 136.3, 134.9, 134.5, 134.2, 131.2, 130.7, 129.6, 129.1, 129.0, 128.4, 127.3, 126.8, 126.8, 126.7, 125.6, 124.4, 123.7, 120.6, 118.6, 116.3, 114.8. FT-IR: ν (cm^{-1}) 2923, 2854, 1585, 1563, 1459, 1440, 1258, 1099, 1075, 1043, 708, 681. HRMS [ESI] calcd for $C_{28}H_{19}NNaO_2S_2^+$ $[M+Na]^+$ 488.0749, found 488.0757.

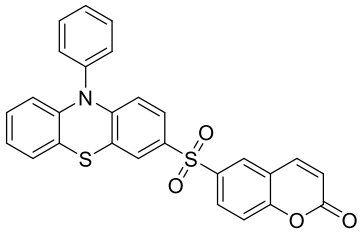


3t: 95% yield, 80.0 mg, yellow solid, m.p. 90-91 °C. Purification by flash column chromatography (eluent: EtOAc/Petroleum ether = 1/20-1/10). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.66-7.60 (m, 3H), 7.59 (d, *J* = 4.8 Hz, 1H), 7.56-7.49 (m, 2H), 7.37 (dd, *J* = 8.8, 2.0 Hz, 1H), 7.33 (d, *J* = 7.6 Hz, 2H), 7.07-7,01 (m, 1H), 6.97-6.92 (m, 1H), 6.86-6.78 (m, 2H), 6.16-6.07 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 148.5, 143.7, 142.7, 139.7, 134.7, 133.3, 132.7, 131.2, 130.7, 129.2, 127.8, 127.4, 126.7, 126.7, 125.5, 123.8, 120.8, 118.6, 116.4, 115.1. FT-IR: ν (cm^{-1}) 3089, 3059, 2160, 1585, 1458, 1258, 1111, 937. HRMS [ESI] calcd for $C_{22}H_{16}NO_2S_3^+$ $[M+H]^+$ 422.0338, found 422.0349.

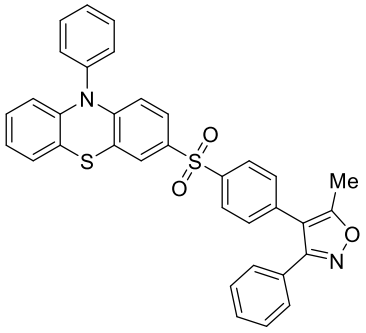


3u: 22% yield, 17.8 mg, yellow oil. Purification by flash column chromatography (eluent: EtOAc/Petroleum ether = 1/10-1/5). ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.07 (s, 1H), 8.76 (s, 1H), 8.13 (d, *J* = 8.0 Hz, 1H), 7.66-7.60 (m, 2H), 7.56-7.51 (m, 1H), 7.48 (d, *J* = 2.0 Hz, 1H), 7.45-7.39 (m, 1H), 7.36-7.30 (m, 3H), 6.98-6.92 (m, 1H), 6.87-6.79 (m, 2H), 6.13 (d, *J* = 8.8 Hz, 1H), 6.11-6.07 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 153.3, 148.9, 148.4, 142.5, 139.6, 134.9, 133.2, 131.3, 130.6, 129.2, 127.4, 127.2, 126.7, 125.8, 123.9, 121.1, 118.5,

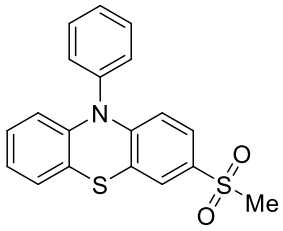
116.5, 115.2. FT-IR: ν (cm^{-1}) 3059, 2922, 2852, 1721, 1585, 1562, 1492, 1458, 1307, 1155, 1126, 740, 723, 678. HRMS [ESI] calcd for $C_{23}H_{17}N_2O_2S_2^+$ $[M+H]^+$ 417.0726, found 417.0727.



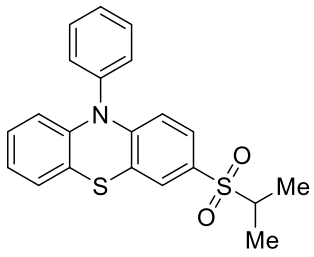
3v: 65% yield, 63.2 mg, yellow solid, m.p. 125-126 ºC. Purification by flash column chromatography (eluent: EtOAc/Petroleum ether = 1/15-1/10). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.07 (d, *J* = 2.4 Hz, 1H), 7.95 (dd, *J* = 8.8, 2.4 Hz, 1H), 7.73 (d, *J* = 9.6 Hz, 1H), 7,65-7.58 (m, 2H), 7.55-7.48 (m, 1H), 7.46 (d, *J* = 2.0 Hz, 1H), 7.37 (d, *J* = 8.8 Hz, 1H), 7.34-7.29 (m, 3H), 6.95-6.89 (m, 1H), 6.85-6.77 (m, 2H), 6.49 (d, *J* = 9.6 Hz, 1H), 6.12 (d, *J* = 8.8 Hz, 1H), 6.10-6.06 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.3, 156.5, 148.7, 142.5, 142.5, 139.6, 138.6, 133.5, 131.3, 130.6, 130.4, 129.2, 127.6, 127.4, 127.0, 126.7, 125.7, 123.9, 121.0, 119.0, 118.4, 118.3, 118.1, 116.5, 115.2. FT-IR: ν (cm^{-1}) 3071, 2931, 1593, 1493, 1391, 1149, 985. HRMS [ESI] calcd for $C_{27}H_{17}NNaO_4S_2^+$ $[M+Na]^+$ 506.0491, found 506.0480.



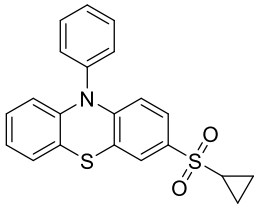
3w: 82% yield, 93.9 mg, yellow solid, m.p. 125-126 ºC. Purification by flash column chromatography (eluent: EtOAc/Petroleum ether = 1/20-1/8). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.85 (d, *J* = 8.4 Hz, 2H), 7.67-7.59 (m, 2H), 7.54 (d, *J* = 7.6 Hz, 1H), 7.51 (d, *J* = 2.4 Hz, 1H), 7.43-7,26 (m, 10H), 6.98-6.91 (m, 1H), 6.87-6.77 (m, 2H), 6.16 (d, *J* = 8.8 Hz, 1H), 6.13-6.08 (m, 1H), 2.45 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 167.4, 161.1, 148.6, 142.7, 141.3, 139.6, 135.5, 133.9, 131.3, 130.7, 130.4, 129.7, 129.2, 128.8, 128.5, 128.4, 127.7, 127.4, 127.2, 126.7, 126.0, 123.8, 120.9, 118.6, 116.5, 115.1, 114.4, 11.8. FT-IR: ν (cm^{-1}) 3060, 2923, 1617, 1585, 1562, 1492, 1459, 1440, 1392, 1258, 1184, 1153, 1115, 937, 725, 708, 661. HRMS [ESI] calcd for $C_{34}H_{24}N_2NaO_3S_2^+$ $[M+Na]^+$ 595.1121, found 595.1127.



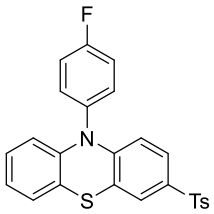
3x: 51% yield, 35.7 mg, yellow solid, m.p. 163-164 ºC. Purification by flash column chromatography (eluent: EtOAc/Petroleum ether = 1/10). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.69-7.62 (m, 2H), 7.58-7.52 (m, 1H), 7.48 (d, *J* = 2.0 Hz, 1H), 7.40-7.34 (m, 2H), 7.31 (dd, *J* = 8.8, 2.4 Hz, 1H), 7.00-6.92 (m, 1H), 6.88-6.80 (m, 2H), 6.16 (d, *J* = 8.8 Hz, 1H), 6.15-6.10 (m, 1H), 2.98 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 148.7, 142.7, 139.8, 133.4, 131.3, 130.7, 129.2, 127.4, 126.8, 126.6, 125.6, 123.8, 120.9, 118.6, 116.4, 115.0, 44.8. FT-IR: ν (cm^{-1}) 2922, 2852, 1600, 1585, 1491, 1444, 1389, 1322, 1280, 1259, 1100, 1003, 889, 820, 771. HRMS [ESI] calcd for $C_{19}H_{15}NNaO_2S_2^+$ $[M+Na]^+$ 376.0436, found 376.0427.



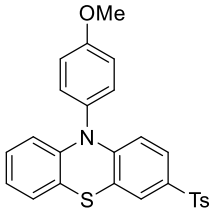
3y: 96% yield, 73.1 mg, yellow oil, Purification by flash column chromatography (eluent: EtOAc/Petroleum ether = 1/20). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.68-7.61 (m, 2H), 7.57-7.50 (m, 1H), 7.41 (d, *J* = 2.0 Hz, 1H), 7.39-7.34 (m, 2H), 7.26-7.21 (m, 1H), 7.00-6.93 (m, 1H), 6.88-6.79 (m, 2H), 6.17 (d, *J* = 8.8 Hz, 1H), 6.15-6.10 (m, 1H), 3.16-3.04 (m, 1H), 1.26 (d, *J* = 6.8 Hz, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 148.7, 142.8, 139.8, 131.3, 130.8, 129.6, 129.2, 128.3, 127.4, 127.1, 126.8, 123.8, 120.6, 118.8, 116.4, 114.8, 55.7, 15.8. FT-IR: ν (cm^{-1}) 3075, 2983, 2922, 2851, 1647, 1583, 1491, 1241, 1075, 939. HRMS [ESI] calcd for $C_{21}H_{20}NO_2S_2^+$ $[M+H]^+$ 382.0930, found 382.0939.



3z: 78% yield, 59.3 mg, yellow solid, m.p. 77-78 °C. Purification by flash column chromatography (eluent: EtOAc/Petroleum ether = 1/15-1/10). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.68-7.62 (m, 2H), 7.57-7.51 (m, 1H), 7.44 (d, *J* = 2.0 Hz, 1H), 7.39-7.35 (m, 2H), 7.29-7.26 (m, 1H), 7.00-6.94 (m, 1H), 6.88-6.80 (m, 2H), 6.17 (d, *J* = 8.8 Hz, 1H), 6.15-6.10 (m, 1H), 2.43-2.34 (m, 1H), 1.28-1.24 (m, 2H), 1.02-0.94 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 148.5, 142,8, 139.8, 133.6, 131.3, 130.8, 129.1, 127.3, 126.8, 126.8, 125.8, 123.7, 120.7, 118.7, 116.4, 115.0, 33.2, 5.9. FT-IR: ν (cm^{-1}) 3155, 3000, 2944, 2160, 1575, 1496, 1447, 1345, 1293, 1217, 1119, 917, 788, 689. HRMS [ESI] calcd for $C_{21}H_{17}NNaO_2S_2^+$ $[M+Na]^+$ 402.0593, found 402.0586.

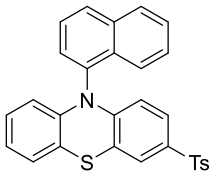


3aa: 92% yield, 82.4 mg, yellow solid, m.p. 90-91 °C. Purification by flash column chromatography (eluent: EtOAc/Petroleum ether = 1/15). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.74 (d, *J* = 8.4 Hz, 2H), 7.47 (d, *J* = 2.0 Hz, 1H), 7.33 (dd, *J* = 8.4, 2.0 Hz, 1H), 7.31-7.27 (m, 4H), 7.26-7.23 (m, 2H), 6.96-6.91 (m, 1H), 6.85-6.80 (m, 2H), 6.12-6.05 (m, 2H), 2.36 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.4 (d, $J_{C\text{-}F}$ = 248.4 Hz), 148.1, 143.9, 142.7, 139.1, 135.6 (d, $J_{C\text{-}F}$ = 3.5 Hz), 135.0, 132.7 (d, $J_{C\text{-}F}$ = 8.5 Hz), 129.9, 127.4, 126.8, 125.8, 123.8, 120.9, 118.9, 118.2 (d, $J_{C\text{-}F}$ = 22.6 Hz), 116.2, 115.0, 21.6; ^{19}F NMR (377 MHz, $CDCl_3$) δ -111.0 (s). FT-IR: ν (cm^{-1}) 3068, 2932, 1592, 1499, 1392, 1299, 1150, 983. HRMS [ESI] calcd for $C_{25}H_{18}FNNaO_2S_2^+$ $[M+Na]^+$ 470.0655, found 470.0645.

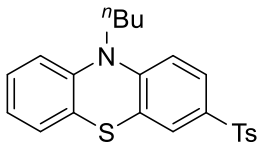


3ab: 86% yield, 78.5 mg, yellow solid, m.p. 88-89 °C. Purification by flash column chromatography (eluent: EtOAc/Petroleum ether = 1/15-1/10). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.80-7.85 (m, 2H), 7.50-7.45 (m, 1H), 7.36-7.32 (m, 1H), 7.30-7.20 (m, 4H), 7.15-7.09 (m, 2H), 6.97-6.91 (m, 1H), 6.88-6.80 (m, 2H), 6.20-6.10 (m, 2H), 3.90 (s, 3H), 2.39 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.7, 148.6, 143.8, 143.1, 139.2, 134.6, 132.1, 131.7, 129.9, 127.3, 127.3, 126.8, 126.7, 125.6, 123.6, 120.6, 118.6, 116.3, 116.3, 115.1, 55.6, 21.6. FT-IR: ν (cm^{-1}) 3057, 2956, 2924, 2841,

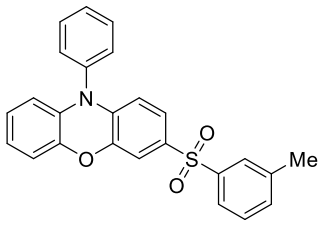
1591, 1391, 1300, 1151, 910. HRMS [ESI] calcd for $C_{26}H_{22}NO_3S_2^+$ $[M+H]^+$ 460.1036, found 460.1045.



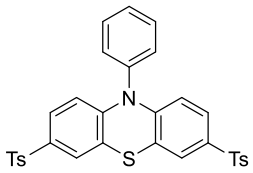
3ac: 90% yield, 86.2 mg, yellow solid, m.p. 105-106 °C. Purification by flash column chromatography (eluent: EtOAc/Petroleum ether = 1/15). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.04-7.93 (m, 3H), 7.77-7.72 (m, 2H), 7.68-7.63 (m, 1H), 7.58-7.53 (m, 2H), 7.52 (d, *J* = 2.4 Hz, 1H), 7.48-7.42 (m, 1H), 7.27-7.24 (m, 2H), 7.20 (dd, *J* = 8.8, 2.4 Hz, 1H), 6.97 (dd, *J* = 7.6, 1.6 Hz, 1H), 6.83-6.78 (m, 1H), 6.72-6.67 (m, 1H), 5.99-5.93 (m, 2H), 2.37 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 147.8, 143.9, 142.3, 139.1, 136.1, 135.5, 134.9, 130.8, 129.9, 129.7, 128.9, 128.9, 127.7, 127.4, 127.1, 126.9, 126.6, 126.6, 125.6, 123.8, 123.1, 120.8, 118.7, 116.5, 115.3, 21.6. FT-IR: ν (cm^{-1}) 3060, 2947, 1592, 1459, 1306, 1245, 1014, 987. HRMS [ESI] calcd for $C_{29}H_{22}NO_2S_2^+$ $[M+H]^+$ 480.1086, found 480.1097.



3ad: 92% yield, 74.8 mg, yellow solid, m.p. 67-68 °C. Purification by flash column chromatography (eluent: EtOAc/Petroleum ether = 1/9). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.78 (d, *J* = 8.5 Hz, 2H), 7.68 (dd, *J* = 9.0, 2.5 Hz, 1H), 7.59 (d, *J* = 2.0 Hz, 1H), 7.27 (d, *J* = 8.5 Hz, 2H), 7.18-7.12 (m, 1H), 7.10-7.05 (m, 1H), 6.98-6.91 (m, 1H), 6.88-6.81 (m, 2H), 3.83 (t, *J* = 7.0 Hz, 2H), 2.38 (s, 3H), 1.78-1.70 (m, 2H), 1.47-1.38 (m, 2H), 0.92 (t, *J* = 7.0 Hz, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 149.6, 143.9, 143.6, 139.2, 134.8, 129.9, 127.7, 127.6, 127.4, 127.2, 126.5, 125.7, 123.6, 123.6, 116.0, 114.9, 47.5, 28.7, 21.6, 20.0, 13.8. FT-IR: ν (cm^{-1}) 3059, 2925, 2870, 1563, 1299, 1150, 1098. HRMS [ESI] cald for $C_{23}H_{23}NNaO_2S_2^+$ $[M+Na]^+$ 432.1062, found 432.1060.

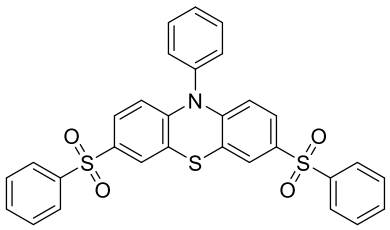


3ae: 92% yield, 76.0 mg, yellow solid, m.p. 156-157 °C. Purification by flash column chromatography (eluent: EtOAc/Petroleum ether = 1/20-1/10). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.73-7.64 (m, 2H), 7.63-7.55 (m, 2H), 7.52-7.46 (m, 1H), 7.38-7.30 (m, 2H), 7.28-7.23 (m, 2H), 7.19-7.10 (m, 2H), 6.70-6.55 (m, 3H), 5.94-5.81 (m, 2H), 2.38 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 144.0, 143.5, 142.1, 139.5, 138.9, 137.5, 133.7, 133.1, 132.8, 131.4, 130.2, 129.3, 127.6, 124.5, 124.0, 123.8, 122.8, 115.6, 114.5, 113.9, 112.8, 21.4. FT-IR: ν (cm^{-1}) 2999, 2940, 2879, 2436, 2117, 1565, 1493, 1458, 1415, 1309, 1258, 1154, 1009, 724, 694. HRMS [ESI] calcd for $C_{25}H_{20}NO_3S^+$ $[M+H]^+$ 414.1158, found 414.1157.

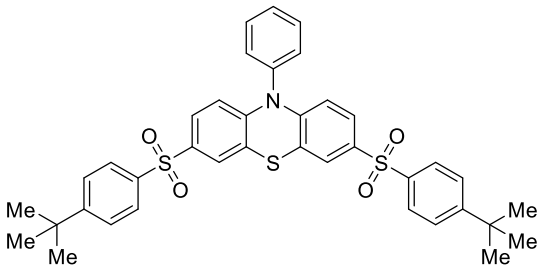


4a: 96% yield, 111.9 mg, yellow solid, m.p. 142-143 °C. Purification by flash column chromatography (eluent: EtOAc/Petroleum ether = 1/10-1/5). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.77-7.70 (m, 4H), 7.66-7.59 (m, 2H), 7.57-7.51 (m, 1H), 7.43 (d, *J* = 2.0 Hz, 2H), 7.32 (dd, *J* = 8.8, 2.4 Hz, 2H), 7.29-7.24 (m,

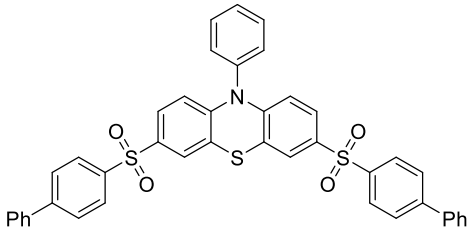
6H), 6.12-6.05 (m, 2H), 2.38 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 146.7, 144.1, 138.9, 138.8, 136.4, 131.6, 130.2, 130.0, 129.7, 127.4, 127.1, 125.7, 120.0, 116.0, 21.6. FT-IR: ν (cm^{-1}) 2974, 2926, 2892, 1455, 1301, 1152, 1044. HRMS [ESI] calcd for $C_{32}H_{25}NNaO_4S_3^+$ $[M+Na]^+$ 606.0838, found 606.0847.



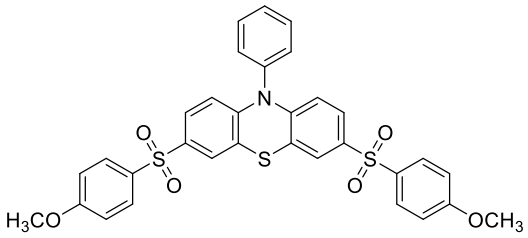
4b: 96% yield, 108.7 mg, yellow solid, m.p. 127-128 °C. Purification by flash column chromatography (eluent: EtOAc/Petroleum ether = 1/10-1/6). ^{1}H NMR (400 MHz, CDCl3) δ 7.88-7.81 (m, 4H), 7.65-7.59 (m, 2H), 7.56-7.50 (m, 3H), 7.49-7.41 (m, 6H), 7.33 (dd, J = 8.8, 2.0 Hz, 2H), 7.26-7.22 (m, 2H), 6.10 (d, J = 8.8 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 146.9, 141.7, 138.7, 136.0, 133.2, 131.6, 130.2, 129.8, 129.3, 127.4, 125.8, 120.1, 116.1. FT-IR: ν (cm-1) 3061, 2925, 1583, 1490, 1391, 1151, 1248, 1112, 902. HRMS [ESI] calcd for $C_{30}H_{22}NO_4S_3^+$ $[M+H]^+$ 556.0705, found 556.0695.



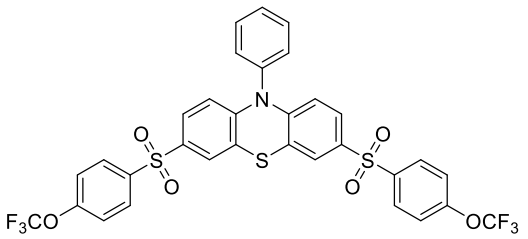
4c: 88% yield, 117.5 mg, yellow solid, m.p. >300 °C. Purification by flash column chromatography (eluent: EtOAc/ Petroleum ether = 1/10-1/4). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.80-7.76 (m, 4H), 7.66-7.61 (m, 2H), 7.58-7.54 (m, 1H), 7.51-7.45 (m, 6H), 7.35 (dd, *J* = 8.8, 2.0 Hz, 2H), 7.29-7.27 (m, 2H), 6.11 (d, *J* = 8.8 Hz, 2H), 1.31 (s, 18H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 157.1, 146.8, 138.9, 138.6, 136.4, 131.5, 130.2, 129.7, 127.3, 127.2, 126.3, 125.8, 120.0, 115.9, 35.2, 31.0. FT-IR: ν (cm^{-1}) 3065, 2957, 2867, 1587, 1491, 1303, 1246, 1101, 906. HRMS [ESI] calcd for $C_{38}H_{38}NO_4S_3^+$ $[M+H]^+$ 668.1957, found 668.1953.



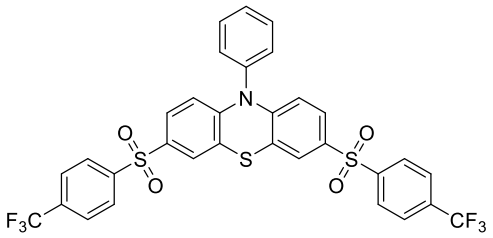
4d: 96% yield, 135.7 mg, yellow solid, m.p. 161-162 °C. Purification by flash column chromatography (eluent: EtOAc/Petroleum ether = 1/10-1/5). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.95-7.90 (m, 4H), 7.69-7.65 (m, 4H), 7.65-7.60 (m, 2H), 7.58-7.52 (m, 5H), 7.50 (d, *J* = 2.0 Hz, 2H), 7.47-7.38 (m, 7H), 7.37 (d, *J* = 2.0 Hz, 1H), 7.28-7.27 (m, 1H), 7.26-7.24 (m, 1H), 6.13 (d, *J* = 8.8 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 146.9, 146.1, 140.2, 139.1, 138.8, 136.2, 131.6, 130.2, 129.8, 129.1, 128.6, 128.0, 127.9, 127.3, 125.9, 120.1, 116.1. FT-IR: ν (cm^{-1}) 3060, 3031, 2922, 1677, 1585, 1479, 1303, 1245, 1078, 938. HRMS [ESI] calcd for $C_{42}H_{30}NO_4S_3^+$ $[M+H]^+$ 708.1331, found 708.1337.



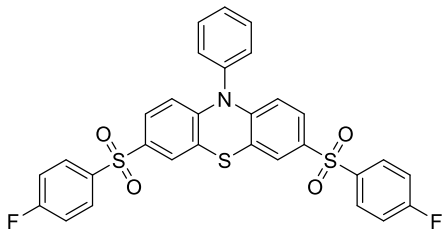
4e: 66% yield, 81.2 mg, yellow solid, m.p. 133-134 °C. Purification by flash column chromatography (eluent: EtOAc/Petroleum ether = 1/6-1/2). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.82-7.77 (m, 4H), 7.65-7.60 (m, 2H), 7.58-7.53 (m, 1H), 7.46-7.41 (m, 2H), 7.33-7.28 (m, 2H), 7.29-7.26 (m, 2H), 6.97-6.92 (m, 4H), 6.12-6.05 (m, 2H), 3.84 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 163.3, 146.6, 138.9, 136.8, 133.2, 131.5, 130.2, 129.7, 129.6, 126.9, 125.5, 120.0, 116.0, 114.6, 55.7. FT-IR: ν (cm^{-1}) 3004, 2942, 2838, 1672, 1588, 1414, 1256, 1113, 1022. HRMS [ESI] calcd for $C_{32}H_{25}KNO_6S_3^+$ $[M+K]^+$ 654.0476, found 654.0482.



4f: 82% yield, 118.1 mg, yellow solid, m.p. 115-116 °C. Purification by flash column chromatography (eluent: EtOAc/Petroleum ether = 1/20-1/10). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.94-7.88 (m, 4H), 7.66-7.60 (m, 2H), 7.58-7.52 (m, 1H), 7.46 (d, *J* = 2.0 Hz, 2H), 7.34 (dd, *J* = 8.8, 2.4 Hz, 2H), 7.31-7.25 (m, 6H), 6.13 (d, *J* = 8.8 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 152.5 (q, J_{C-F} = 1.9 Hz), 147.1, 140.1, 138.7, 135.5, 131.7, 130.1, 129.9, 129.6, 127.5, 125.9, 121.1, 120.3, 120.2 (q, J_{C-F} = 258.1 Hz), 116.2; ^{19}F NMR (377 MHz, $CDCl_3$) δ -57.7 (s). FT-IR: ν (cm^{-1}) 3102, 3066, 2925, 1586, 1459, 1303, 1210, 1015, 901. HRMS [EI] calcd for $C_{32}H_{19}F_6NO_6S_3^+$ $[M]^+$ 723.0273, found 723.0272.

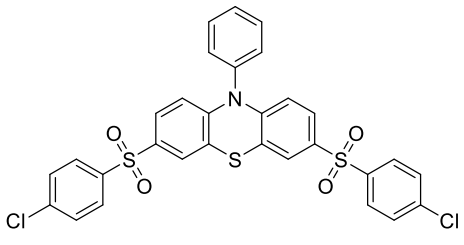


4g: 96% yield, 131.6 mg, yellow solid, m.p. 140-141 °C. Purification by flash column chromatography (eluent: EtOAc/Petroleum ether = 1/15). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.00 (d, *J* = 8.0 Hz, 4H), 7.75 (d, *J* = 8.4 Hz, 4H), 7.68-7.63 (m, 2H), 7.60-7.54 (m, 1H), 7.47 (d, *J* = 2.0 Hz, 2H), 7.36 (dd, *J* = 8.8, 2.4 Hz, 2H), 7.29-7.26 (m, 2H), 6.13 (d, *J* = 8.8 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 147.2, 145.3, 138.6, 135.0, 134.8 (q, J_{C-F} = 33.0 Hz), 131.7, 130.1, 129.9, 128.0, 127.7, 126.5 (q, J_{C-F} = 3.7 Hz), 126.1, 123.1 (q, J_{C-F} = 271.3 Hz), 120.3, 116.2; ^{19}F NMR (377 MHz, $CDCl_3$) δ -63.2 (s). FT-IR: ν (cm^{-1}) 3061, 2957, 2923, 2852, 1723, 1681, 1458, 1247, 1133, 1060. HRMS [ESI] calcd for $C_{32}H_{20}F_6NO_4S_3^+$ $[M+H]^+$ 692.0453, found 692.0454.

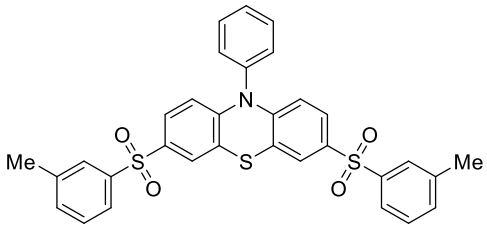


4h: 91% yield, 107.8 mg, yellow solid, m.p. 119-120 °C. Purification by flash column chromatography (eluent: EtOAc/Petroleum ether = 1/10-1/5). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.91-7.84 (m, 4H), 7.67-7.61 (m, 2H), 7.58-7.53 (m,

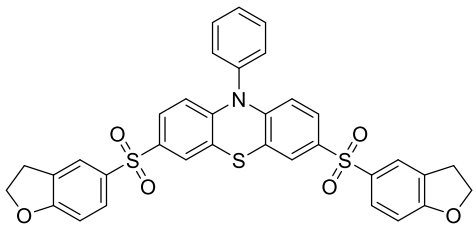
1H), 7.44 (d, *J* = 2.4 Hz, 2H), 7.33 (dd, *J* = 8.8, 2.4 Hz, 2H), 7.30-7.26 (m, 2H), 7.19-7.12 (m, 4H), 6.12 (d, *J* = 8.8 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 165.4 (d, J_{C-F} = 254.4 Hz), 146.9, 138.7, 137.8 (d, J_{C-F} = 3.2 Hz), 135.9, 131.6, 130.3, 130.2 (d, J_{C-F} = 1.4 Hz), 129.8, 127.3, 125.8, 120.2, 116.6 (d, J_{C-F} = 22.5 Hz), 116.1; ^{19}F NMR (377 MHz, $CDCl_3$) δ -104.1 (s). FT-IR: ν (cm^{-1}) 3102, 3067, 1586, 1560, 1491, 1455, 1397, 1307, 1288, 1235, 1149, 1113, 1076, 834, 753, 674. HRMS [ESI] calcd for $C_{30}H_{19}F_2NNaO_4S_3^+$ $[M+Na]^+$ 614.0336, found 614.0335.



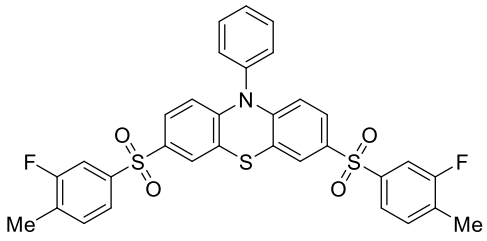
4i: 85% yield, 106.4 mg, yellow solid, m.p. 156-157 °C. Purification by flash column chromatography (eluent: EtOAc/Petroleum ether = 1/20-1/10). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.84-7.76 (m, 4H), 7.67-7.61 (m, 2H), 7.59-7.53 (m, 1H), 7.49-7.40 (m, 6H), 7.33 (dd, *J* = 8.4, 2.0 Hz, 2H), 7.29-7.25 (m, 2H), 6.12 (d, *J* = 8.8 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 147.0, 140.2, 139.8, 138.7, 135.6, 131.6, 130.1, 129.8, 129.7, 128.9, 127.4, 125.8, 120.2, 116.2. FT-IR: ν (cm^{-1}) 3066, 2947, 1592, 1302, 1244, 1151, 1016, 985. HRMS [EI] calcd for $C_{30}H_{19}Cl_2NO_4S_3^+$ $[M]^+$ 622.9848, found 622.9850.



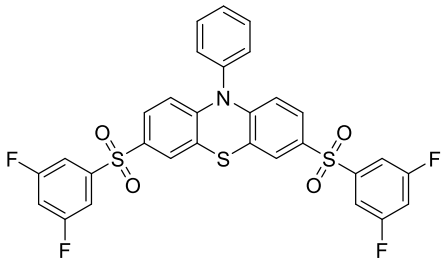
4j: 66% yield, 77.6 mg, yellow solid, m.p. 107-108 °C. Purification by flash column chromatography (eluent: EtOAc/Petroleum ether = 1/10-1/4). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.69-7.61 (m, 6H), 7.58-7.53 (m, 1H), 7.47 (d, *J* = 2.0 Hz, 2H), 7.37-7.32 (m, 6H), 7.29-7.26 (m, 2H), 6.12 (d, *J* = 8.8 Hz, 2H), 2.39 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 146.8, 141.5, 139.6, 138.8, 136.2, 134.0, 131.6, 130.2, 129.7, 129.2, 127.7, 127.3, 125.8, 124.6, 120.0, 116.0, 21.4. FT-IR: ν (cm^{-1}) 3062, 2922, 2854, 1584, 1560, 1492, 1456, 1393, 1300, 1245, 1110, 1077, 727, 684. HRMS [ESI] calcd for $C_{32}H_{26}NO_4S_3^+$ $[M+H]^+$ 584.1018, found 584.1015.



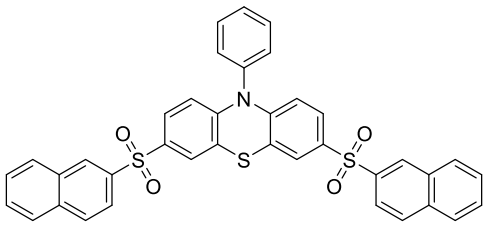
4k: 54% yield, 68.9 mg, yellow solid, m.p. 142-143 °C. Purification by flash column chromatography (eluent: EtOAc/Petroleum ether = 1/10-1/4). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.67-7.58 (m, 6H), 7.57-7.50 (m, 1H), 7.41 (d, *J* = 2.0 Hz, 2H), 7.30 (dd, *J* = 8.8, 2.0 Hz, 2H), 7.26-7.24 (m, 2H), 6.80-6.76 (m, 2H), 6.11-6.06 (m, 2H), 4.62 (t, *J* = 8.8 Hz, 4H), 3.21 (t, *J* = 8.8 Hz, 4H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 164.3, 146.6, 138.9, 137.0, 133.2, 131.5, 130.3, 129.7, 129.2, 128.8, 126.9, 125.5, 124.7, 120.0, 115.9, 109.8, 72.4, 29.0. FT-IR: ν (cm^{-1}) 3063, 2957, 2901, 1601, 1561, 1457, 1302, 1174, 1097, 979. HRMS [ESI] calcd for $C_{34}H_{26}NO_6S_3^+$ $[M+H]^+$ 640.0917, found 640.0907.



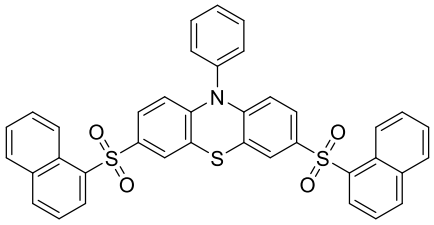
4l: 96% yield, 118.8 mg, yellow solid, m.p. 120-121 °C. Purification by flash column chromatography (eluent: EtOAc/Petroleum ether = 1/10-1/6). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.65-7.61 (m, 2H), 7.57-7.52 (m, 3H), 7.47 (dd, *J* = 8.4, 1.2 Hz, 2H), 7.42 (d, *J* = 2.0 Hz, 2H), 7.33 (d, *J* = 2.0 Hz, 1H), 7.32-7.26 (m, 4H), 7.25-7.23 (m, 1H), 6.11 (d, *J* = 8.8 Hz, 2H), 2.28 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 160.9 (d, J_{C-F} = 249.2 Hz), 147.0, 140.9 (d, J_{C-F} = 6.5 Hz), 138.7, 135.7, 132.5 (d, J_{C-F} = 4.8 Hz), 131.6, 131.3 (d, J_{C-F} = 17.2 Hz), 130.1, 129.8, 127.4, 125.8, 123.0 (d, J_{C-F} = 3.7 Hz), 120.2, 116.1, 114.3 (d, J_{C-F} = 25.2 Hz), 14.8 (d, J_{C-F} = 3.4 Hz); ^{19}F NMR (377 MHz, $CDCl_3$) δ -113.3 (s). FT-IR: ν (cm^{-1}) 3065, 2924, 1591, 1498, 1302, 1245, 1023, 989. HRMS [ESI] calcd for $C_{32}H_{24}F_2NO_4S_3^+$ $[M+H]^+$ 620.0830, found 620.0822.



4m: 54% yield, 67.9 mg, yellow solid, m.p. 227-228 °C. Purification by flash column chromatography (eluent: EtOAc/Petroleum ether = 1/15-1/10). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.68-7.63 (m, 2H), 7.60-7.55 (m, 1H), 7.44 (d, *J* = 2.4 Hz, 2H), 7.42-7.36 (m, 4H), 7.34 (dd, *J* = 8.8, 2.4 Hz, 2H), 7.30-7.27 (m, 2H), 7.02-6.95 (m, 2H), 6.15 (d, *J* = 8.8 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.9 (dd, J_{C-F} = 253.9, 11.3 Hz), 147.3, 145.1 (t, J_{C-F} = 7.9 Hz), 138.5, 134.6, 131.7, 130.1, 130.0, 127.8, 126.1, 120.4, 116.3, 111.0 (dd, J_{C-F} = 19.6, 8.2 Hz) 108.8 (t, J_{C-F} = 24.8 Hz); ^{19}F NMR (377 MHz, $CDCl_3$) δ -104.9 (s). FT-IR: ν (cm^{-1}) 3090, 2922, 2853, 1604, 1500, 1380, 1196, 985. HRMS [ESI] calcd for $C_{30}H_{18}F_4NO_4S_3^+$ $[M+H]^+$ 628.0329, found 628.0326.

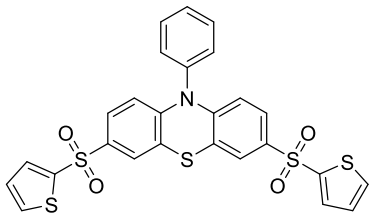


4n: 96% yield, 125.8 mg, yellow solid, m.p. 150-151 °C. Purification by flash column chromatography (eluent: EtOAc/Petroleum ether = 1/10). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.48 (s, 2H), 7.95-7.84 (m, 4H), 7.84-7.73 (m, 4H), 7.61-7.48 (m, 9H), 7.39 (dd, *J* = 8.8, 0.8 Hz, 2H), 7.18 (d, *J* = 7.2 Hz, 2H), 6.08 (d, *J* = 7.2 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 146.8, 138.7, 138.5, 136.0, 134.9, 132.2, 131.6, 130.2, 129.8, 129.4, 129.2, 128.8, 127.9, 127.7, 127.5, 125.9, 122.4, 120.1, 116.1. FT-IR: ν (cm^{-1}) 3057, 2924, 2853, 1585, 1457, 1302, 1246, 1067, 904. HRMS [ESI] calcd for $C_{38}H_{25}NNaO_4S_3^+$ $[M+Na]^+$ 678.0838, found 678.0848.

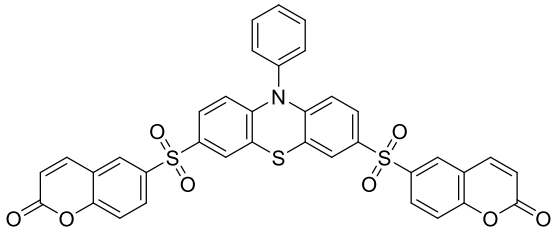


4o: 92% yield, 120.7 mg, yellow solid, m.p. 279-280 °C. Purification by flash column chromatography (eluent: EtOAc/Petroleum ether = 1/10-1/6). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.58 (d, *J* = 8.4 Hz, 2H), 8.40 (d, *J* = 7.2 Hz, 2H), 8.05 (d, *J*

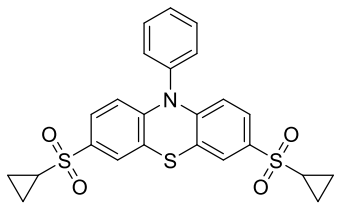
= 8.4 Hz, 2H), 7.87 (d, *J* = 8.0 Hz, 2H), 7.60-7.48 (m, 9H), 7.43 (d, *J* = 0.8 Hz, 2H), 7.38 (dd, *J* = 8.8, 2.0 Hz, 2H), 7.16 (d, *J* = 7.6 Hz, 2H), 6.03 (d, *J* = 8.4 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 146.7, 138.8, 136.1, 135.8, 135.1, 134.2, 131.5, 130.2, 129.8, 129.7, 129.1, 128.5, 128.3, 127.1, 126.9, 125.6, 124.4, 124.2, 119.9, 115.7. FT-IR: ν (cm^{-1}) 3060, 2923, 2852, 1584, 1561, 1505, 1456, 1394, 1303, 1154, 1099, 768, 727, 679. HRMS [ESI] calcd for $C_{38}H_{25}NNaO_4S_3^+$ $[M+Na]^+$ 678.0838, found 678.0846.



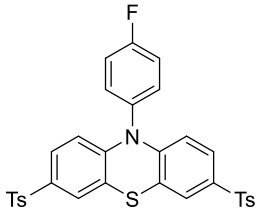
4p: 96% yield, 112.7 mg, yellow solid, m.p. 130-131 ºC. Purification by flash column chromatography (eluent: EtOAc/Petroleum ether = 1/10-1/3). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.66-7.55 (m, 7H), 7.50-7.45 (m, 2H), 7.39-7.33 (m, 2H), 7.30-7.26 (m, 2H), 7.06-7.01 (m, 2H), 6.12 (d, *J* = 8.8 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 146.9, 143.1, 138.7, 136.4, 133.8, 133.1, 131.7, 130.2, 129.8, 129.0, 127.1, 125.5, 120.1, 116.1. FT-IR: ν (cm^{-1}) 3344, 3020, 2948, 1569, 1509, 1477, 1400, 1344, 1312, 1201, 1151, 1108, 772, 719. HRMS [ESI] calcd for $C_{26}H_{18}NO_4S_5^+$ $[M+H]^+$ 567.9834, found 567.9823.



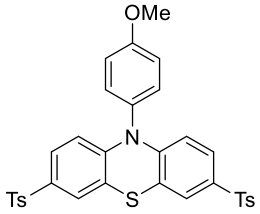
4q: 52% yield, 71.9 mg, yellow solid, m.p. >300 ºC. Purification by flash column chromatography (eluent: EtOAc/Petroleum ether = 1/6-1/2). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.07-8.03 (m, 2H), 7.94 (d, *J* = 8.4 Hz, 2H), 7.72 (d, *J* = 9.2 Hz, 2H), 7.69-7.51 (m, 4H), 7.48-7.43 (m, 2H), 7.39 (d, *J* = 8.8 Hz, 2H), 7.34 (d, *J* = 8.4 Hz, 2H), 7.25-7.21 (m, 1H), 6.52 (d, *J* = 9.6 Hz, 2H), 6.11 (d, *J* = 8.4 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.1, 156.7, 147.0, 142.3, 138.6, 138.0, 135.5, 131.7, 130.4, 130.1, 129.9, 127.7, 127.5, 125.8, 120.3, 119.1, 118.5, 118.3, 116.2. FT-IR: ν (cm^{-1}) 3064, 2924, 2851, 1731, 1621, 1459, 1227, 1109, 932. HRMS [ESI] calcd for $C_{36}H_{22}NO_8S_3^+$ $[M+H]^+$ 692.0502, found 692.0510.



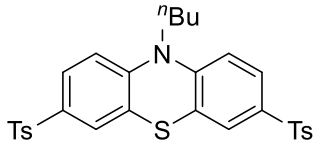
4r: 96% yield, 92.7 mg, yellow solid, m.p. 95-96 ºC. Purification by flash column chromatography (eluent: EtOAc/Petroleum ether = 1/5-1/1.5). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.70-7.65 (m, 2H), 7.60-7.55 (m, 1H), 7.42 (d, *J* = 2.4 Hz, 2H), 7.38-7.31 (m, 2H), 7.28 (dd, *J* = 8.8, 2.0 Hz, 2H), 6.18 (d, *J* = 8.4 Hz, 2H), 2.42-2.34 (m, 2H), 1.28-1.22 (m, 4H), 1.03-0.95 (m, 4H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 147.1, 138.9, 135.1, 131.7, 130.3, 129.8, 127.2, 125.8, 120.0, 116.0, 33.1, 6.0. FT-IR: ν (cm^{-1}) 2922, 2853, 1585, 1562, 1492, 1458, 1393, 1306, 1288, 1103, 1071, 904, 719, 660. HRMS [ESI] calcd for $C_{24}H_{22}NO_4S_3^+$ $[M+H]^+$ 484.0705, found 484.0705.



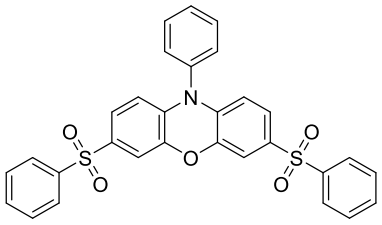
4s: 80% yield, 96.0 mg, yellow solid, m.p. 145-146 °C. Purification by flash column chromatography (eluent: EtOAc/Petroleum ether = 1/10-1/5). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.75 (d, *J* = 8.4 Hz, 4H), 7.47-7.44 (m, 2H), 7.37 (dd, *J* = 8.4, 2.4 Hz, 2H), 7.34-7.31 (m, 2H), 7.30-7.27 (m, 6H), 6.12 (d, *J* = 8.4 Hz, 2H), 2.39 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.7 (d, J_{C-F} = 249.7 Hz), 146.7, 144.2, 138.7, 136.6, 134.7 (d, J_{C-F} = 3.5 Hz), 132.3 (d, J_{C-F} = 8.6 Hz), 130.0, 127.4, 127.2, 125.8, 120.3, 118.7 (d, J_{C-F} = 22.7 Hz), 115.9, 21.6; ^{19}F NMR (377 MHz, $CDCl_3$) δ -109.8 (s). FT-IR: ν (cm^{-1}) 3062, 2922, 2856, 1597, 1505, 1243, 1016, 917. HRMS [CI] calcd for $C_{32}H_{24}FNO_4S_3$ [M] 601.0851, found 601.0849.



4t: 96% yield, 117.7 mg, yellow solid, m.p. 122-123 °C. Purification by flash column chromatography (eluent: EtOAc/Petroleum ether = 1/10-1/5). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.77-7.72 (m, 4H), 7.43 (d, *J* = 2.0 Hz, 2H), 7.34 (dd, *J* = 8.8, 2.0 Hz, 2H), 7.29-7.26 (m, 4H), 7.17-7.09 (m, 4H), 6.16 (d, *J* = 8.4 Hz, 2H), 3.88 (s, 3H), 2.38 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 160.1, 147.1, 144.1, 138.8, 136.2, 131.2, 131.2, 130.0, 127.4, 127.1, 125.7, 120.0, 116.6, 116.0, 55.7, 21.6. FT-IR: ν (cm^{-1}) 3069, 2944, 1596, 1461, 1397, 1190, 971. HRMS [ESI] calcd for $C_{33}H_{28}NO_5S_3^+$ $[M+H]^+$ 614.1124, found 614.1134.

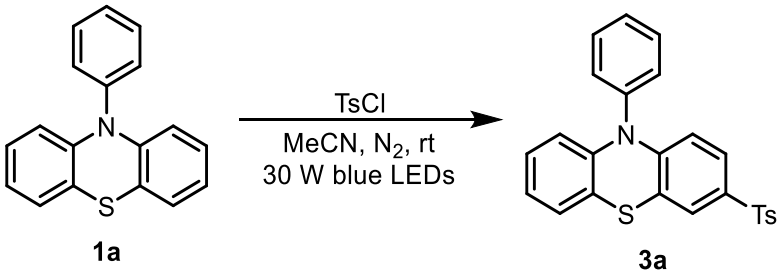


4u: 71% yield, 80.0 mg, yellow solid, m.p. 98-99 °C. Purification by flash column chromatography (eluent: EtOAc/Petroleum ether = 1/5). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.77 (d, *J* = 8.0 Hz, 4H), 7.69 (dd, *J* = 8.8, 2.0 Hz, 2H), 7.53 (d, *J* = 2.4 Hz, 2H), 7.27 (d, *J* = 6.4 Hz, 4H), 6.86 (d, *J* = 8.4 Hz, 2H), 3.82 (t, *J* = 6.8 Hz, 2H), 2.37 (s, 6H), 1.72-1.64 (m, 2H), 1.43-1.34 (m, 2H), 0.89 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 148.0, 144.2, 138.8, 136.4, 130.0, 127.5, 127.5, 126.6, 124.9, 115.8, 47.9, 28.5, 21.6, 19.9, 13.6. FT-IR: ν (cm^{-1}) 2973, 2892, 1649, 1455, 1319, 1086, 1044. HRMS [EI] calcd for $C_{30}H_{29}NO_4S_3^+$ $[M]^+$ 563.1253, found 563.1259.



4v: 60% yield, 65.2 mg, yellow solid, m.p. 120-121 °C. Purification by flash column chromatography (eluent: EtOAc/Petroleum ether = 1/15-1/10). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.89-7.84 (m, 4H), 7.64-7.58 (m, 2H), 7.57-7.52 (m, 3H), 7.51-7.45 (m, 4H), 7.23-7.20 (m, 2H), 7.18 (dd, *J* = 8.4, 2.0 Hz, 2H), 7.14 (d, *J* = 2.0 Hz, 2H), 5.89 (d, *J* = 8.4 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.6, 141.8, 137.4, 136.4, 134.8, 133.1, 131.8, 129.9, 129.6, 129.3, 127.3, 124.4, 114.8, 113.8. FT-IR: ν (cm^{-1}) 2996, 2924, 1622, 1572, 1483, 1343, 1204, 933. HRMS [ESI] calcd for $C_{30}H_{21}NNaO_5S_2^+$ $[M+Na]^+$ 562.0753, found 562.0760.

4. Light on/off experiments



1a 3a

On/ Off	On	On	Off	On	Off	On	Off
Time/ h	0	2	4	6	8	10	12
Yield	0	12%	12%	22%	22%	42%	42%

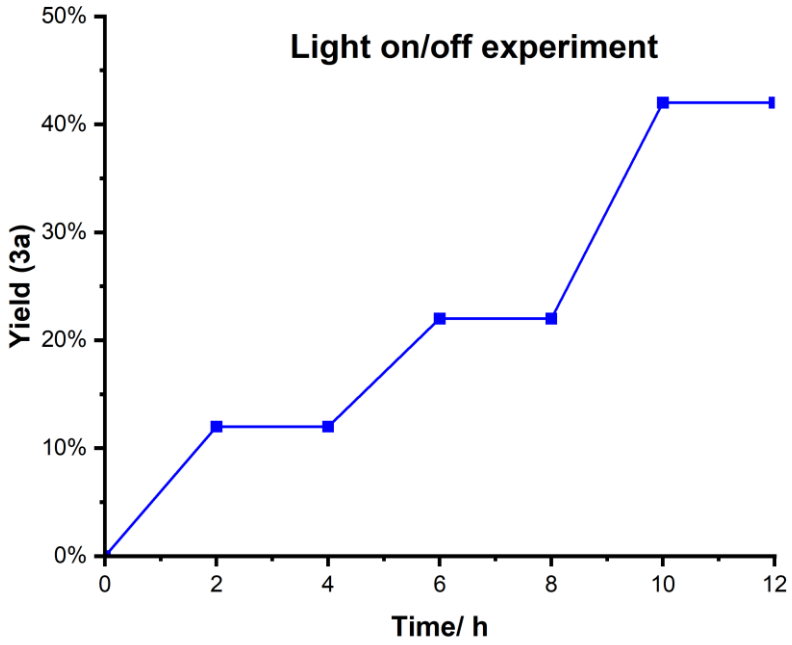


Figure S1 Light on/off experiments

5. UV-Vis absorption and photoluminescence spectroscopy of 3a and 4a

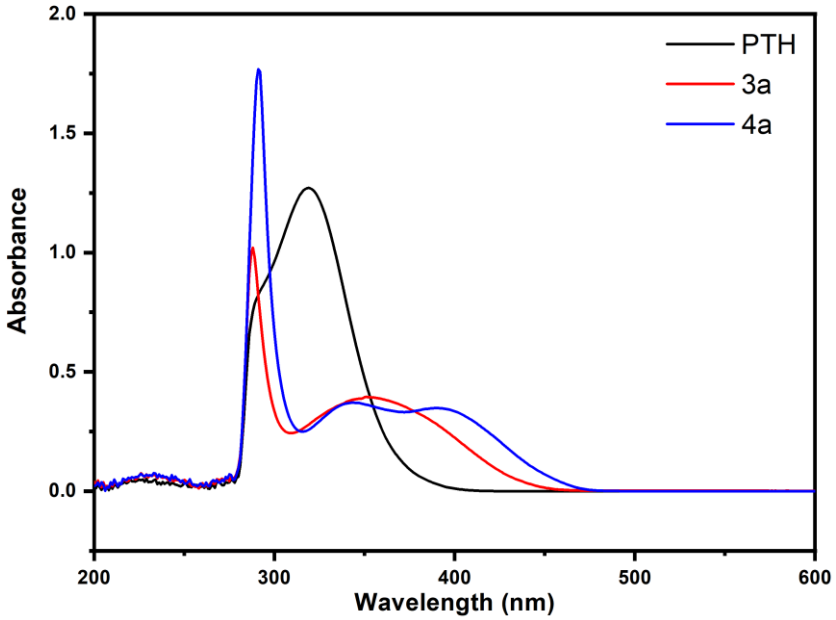


Figure S2 UV-Vis absorption spectroscopy of **3a** and **4a** in MeCN

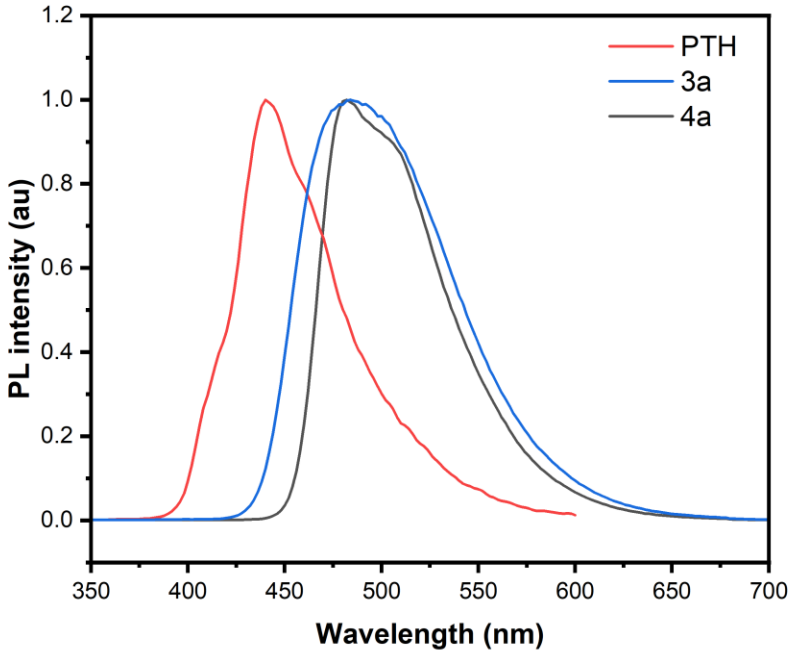
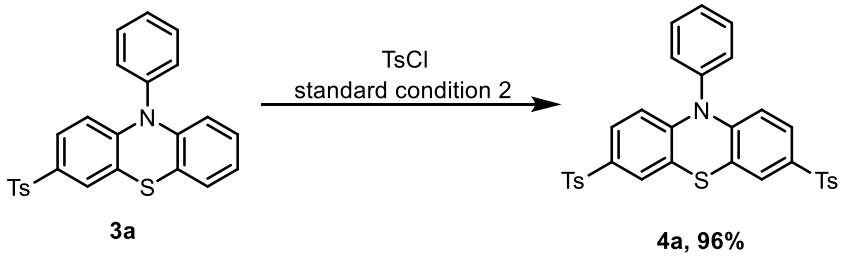


Figure S3 Photoluminescence spectroscopy of **3a** and **4a** in MeCN

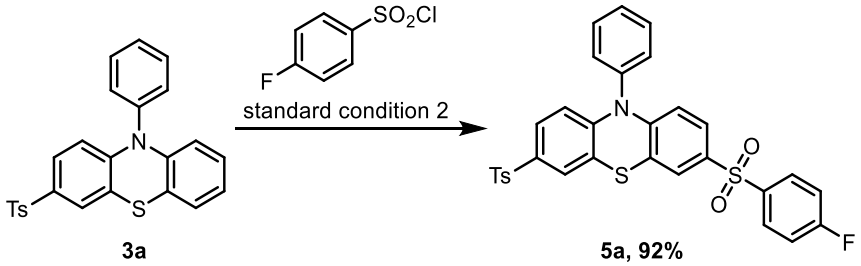
6. Mechanistic experiments

6.1 Crossover experiment



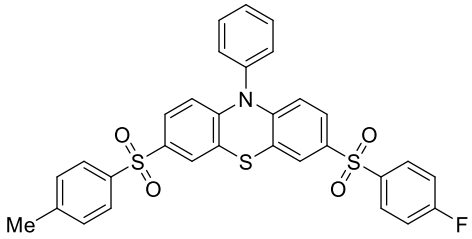
3a **4a, 96%**

3a (0.2 mmol) and TsCl (0.8 mmol) were loaded in a flask, which was subjected to evacuation/ flushing with N_2 for 3 times. MeCN (1.0 mL) was added to the mixture via syringe, which was irradiated by 30 W blue LEDs (450 nm wavelength) and stirred at rt for 48 h. The mixture was concentrated in vacuo, and purified by flash column chromatography on silica gel (eluent: ethyl acetate/petroleum ether) to give **4a**.



3a **5a, 92%**

3a (0.2 mmol) and 4-fluorobenzenesulfonyl chloride (0.8 mmol) were loaded in a flask, which was subjected to evacuation/ flushing with N_2 for 3 times. MeCN (1.0 mL) was added to the mixture via syringe, which was irradiated by 30 W blue LEDs (450 nm wavelength) and stirred at rt for 48 h. The mixture was concentrated in vacuo, and purified by flash column chromatography on silica gel (eluent: ethyl acetate/petroleum ether) to give **5a**.



5a: 92% yield, 108.0 mg, yellow solid, m.p. 126-127 ^{o}C. Purification by flash column chromatography (eluent: EtOAc/Petroleum ether = 1/10-1/6). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.90-7.82 (m, 2H), 7.73 (d, J = 8.4 Hz, 2H), 7.65-7.60 (m, 2H), 7.56-7.52 (m, 1H), 7.45-7.40 (m, 2H), 7.34-7.29 (m, 2H), 7.26-7.22 (m, 4H), 7.17-7.10 (m, 2H), 6.10 (dd, J = 8.8, 4.0 Hz, 2H), 2.36 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 165.4 (d, $J_{C\text{-}F}$ = 254.3 Hz), 147.0, 146.6, 144.2, 138.8, 138.7, 137.8 (d, $J_{C\text{-}F}$ = 3.2 Hz), 136.5, 135.7, 131.6, 130.3, 130.2, 130.2, 130.0, 129.8, 127.4, 127.3, 127.2, 125.7 (d, $J_{C\text{-}F}$ = 3.1 Hz), 120.3, 120.0, 116.3 (d, $J_{C\text{-}F}$ = 22.6 Hz), 116.1, 116.1, 21.6. FT-IR: ν (cm^{-1}) 3100, 3064, 2923, 1586, 1456, 1303, 1150, 1016, 938. HRMS [ESI] calcd for $C_{31}H_{22}FNNaO_4S_3^+$ $[M+Na]^+$ 610.0587, found 610.0585.

6.2 Fluorescence quenching experiments (Stern–Volmer studies)

Emission intensities were recorded using a FLS980 (Edinburgh Instrument, UK) luminescence spectrophotometer. All PTH solutions were excited at 340 nm and the emission intensity was collected at 442 nm. In a typical experiment, to a $3 \cdot 10^{-3}$ M solution of PTH in MeCN was added the appropriate amount of a quencher TsCl in a screw-top quartz cuvette. After degassing the sample with a stream of N_2 for 10 minutes, the emission of the sample was collected.

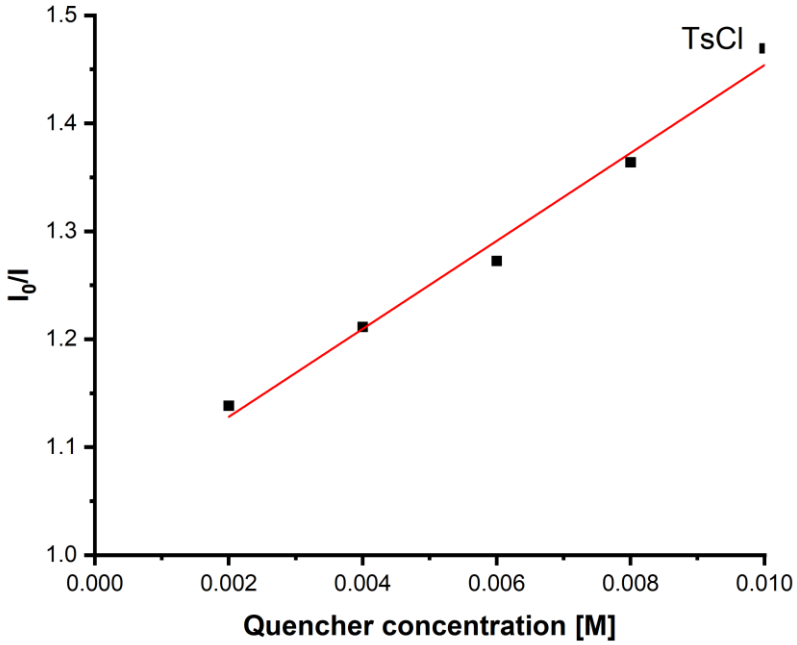


Fig. S4 Fluorescence quenching experiments

6.3 Kinetic experiments

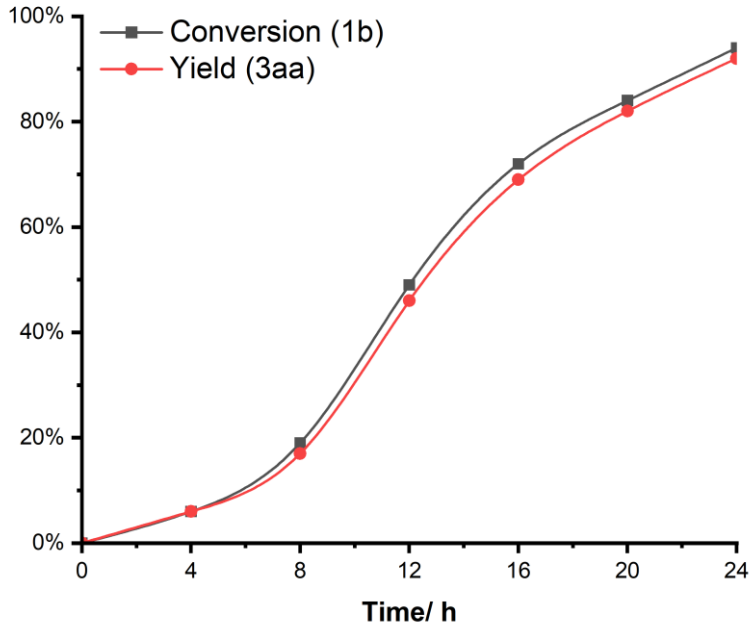


Fig. S5 Yield-time curve of mono-sulfonylation of **1b**

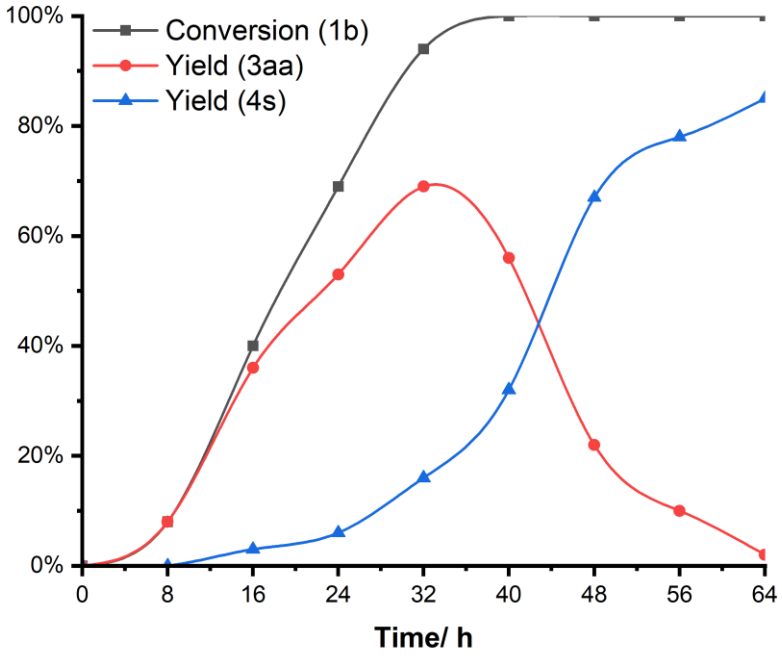


Fig. S6 Yield-time curve of di-sulfonylation of **1b**

6.4 Cyclic voltammogram of 3a and 4a

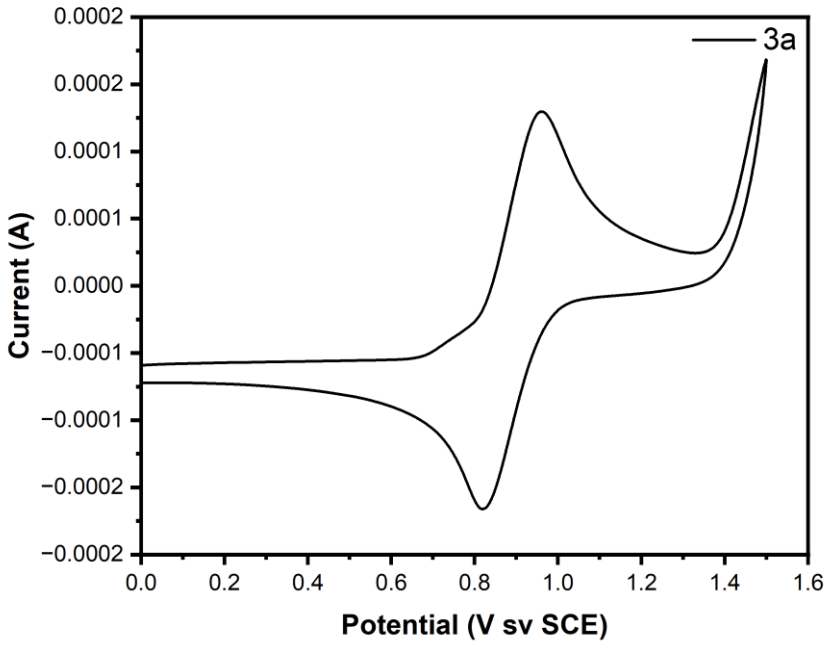
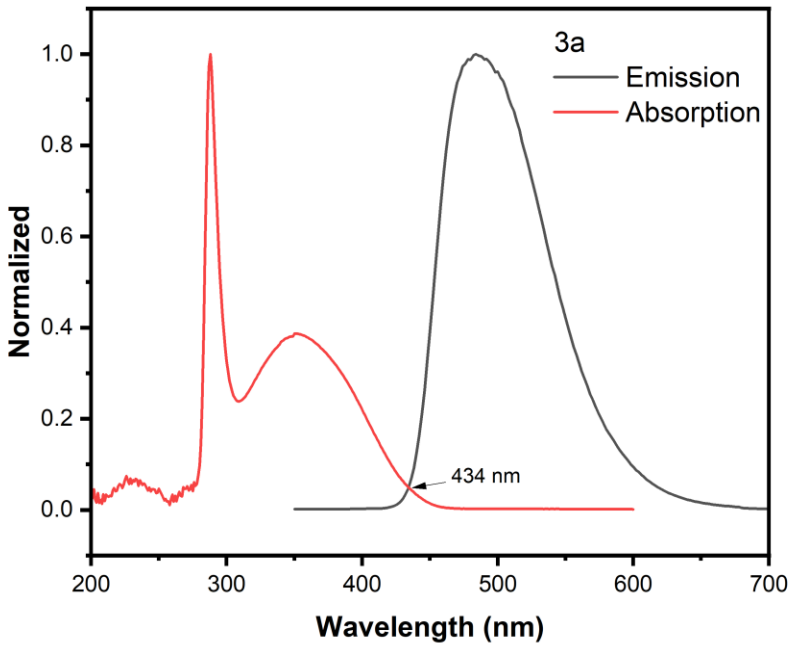


Fig. S7 Cyclic voltammogram of **3a** vs SCE in MeCN at 0.1 V/s



Using the ground state reduction potential of **3a** ($E_{1/2}(P^{\bullet+}/P)$ = 0.90 V vs SCE, **Fig. S7**), the excited state oxidation potential for **3a** was estimated from the crossing point of the normalized absorption and emission spectra (433 nm), $E_{1/2}(P^{*}/P^{\bullet+})$ = -1.95 V vs SCE was obtained.

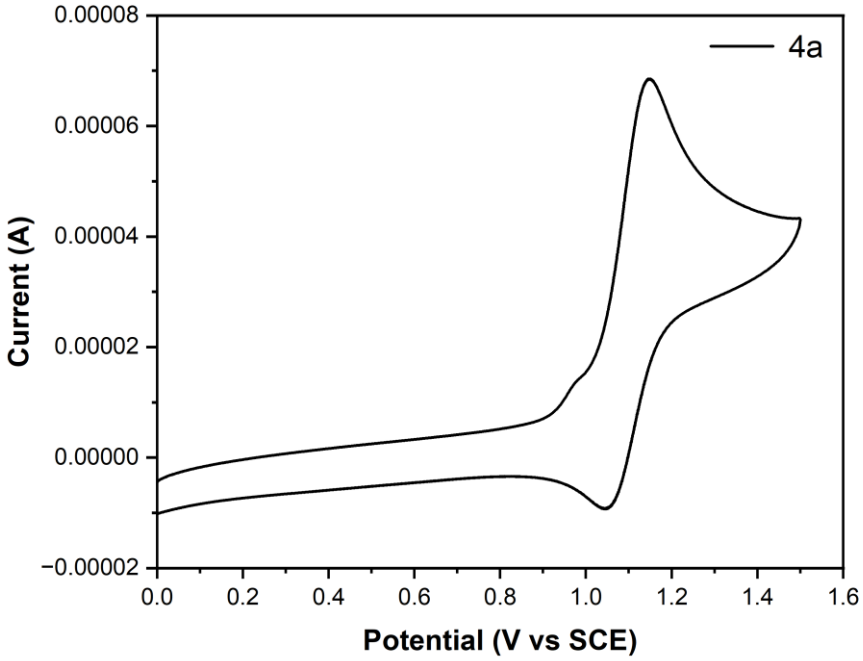
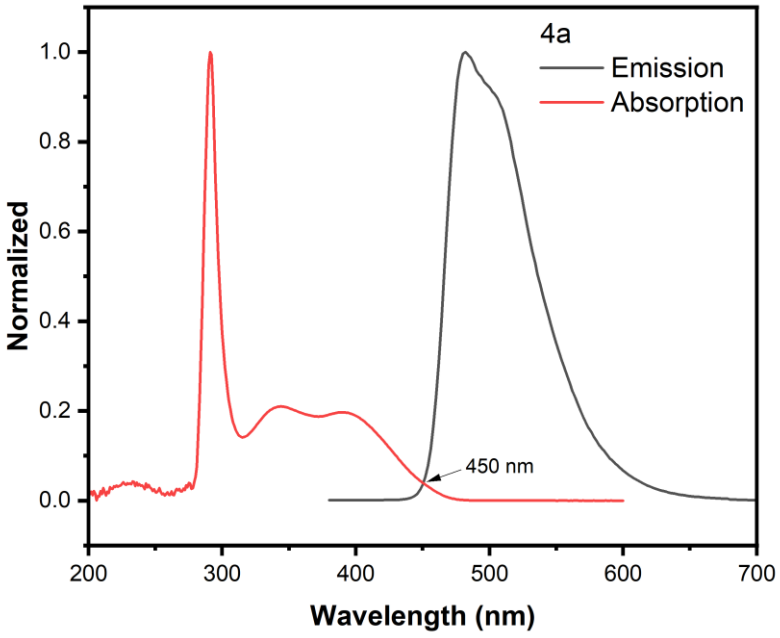


Fig. S8 Cyclic voltammogram of **4a** vs SCE in MeCN at 0.1 V/s



Using the ground state reduction potential of **4a** ($E_{1/2}(P^{\bullet+}/P)$ = 1.15 V vs SCE, **Fig. S8**), the excited state oxidation potential for **4a** was estimated from the crossing point of the normalized absorption and emission spectra (450 nm), $E_{1/2}(P^{*}/P^{\bullet+})$ = -1.60 V vs SCE was obtained.

6.5 UV-Vis studies

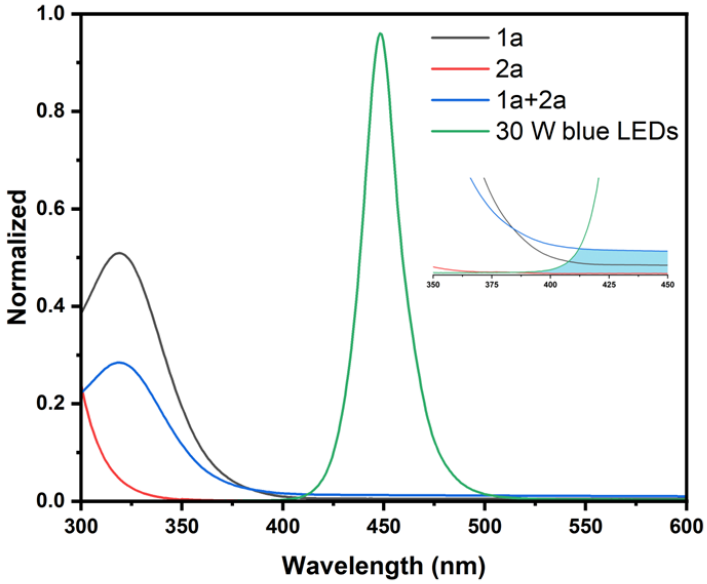
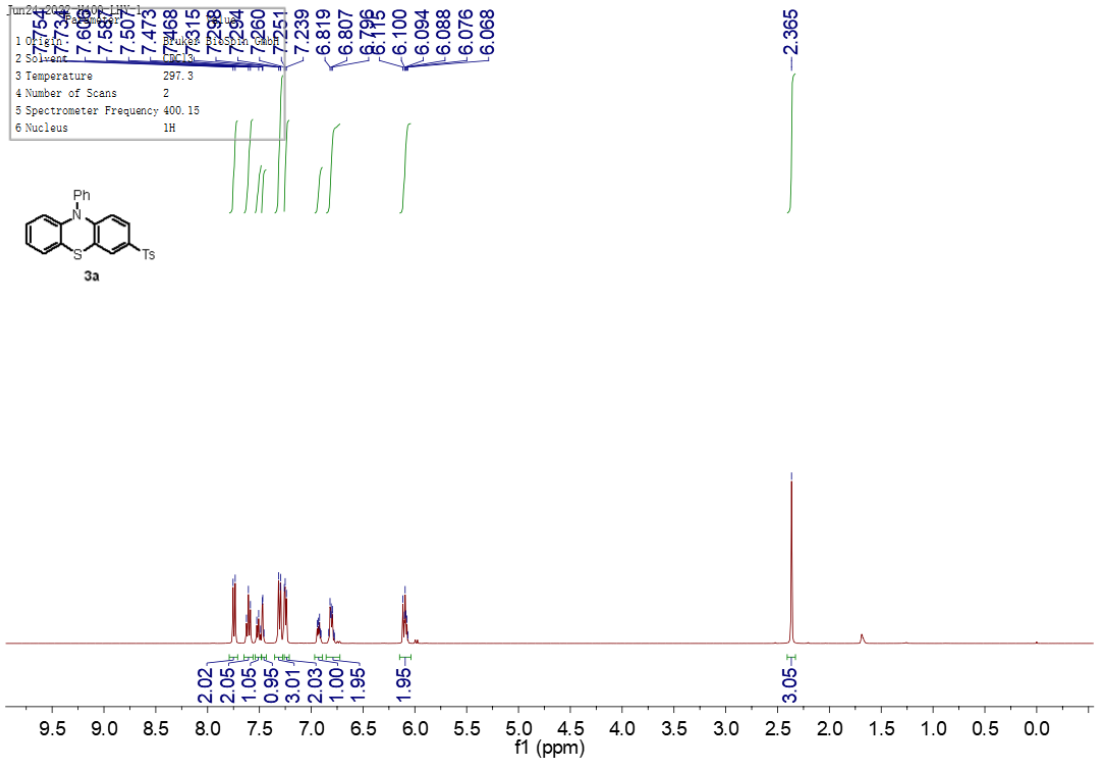
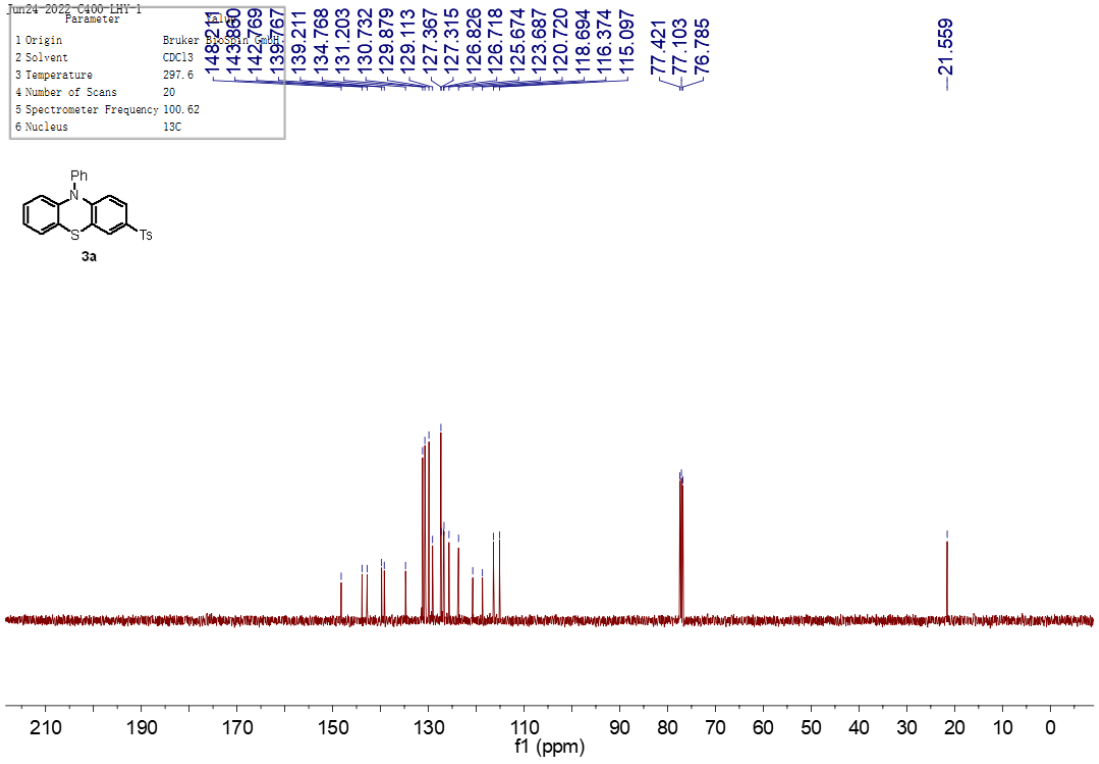
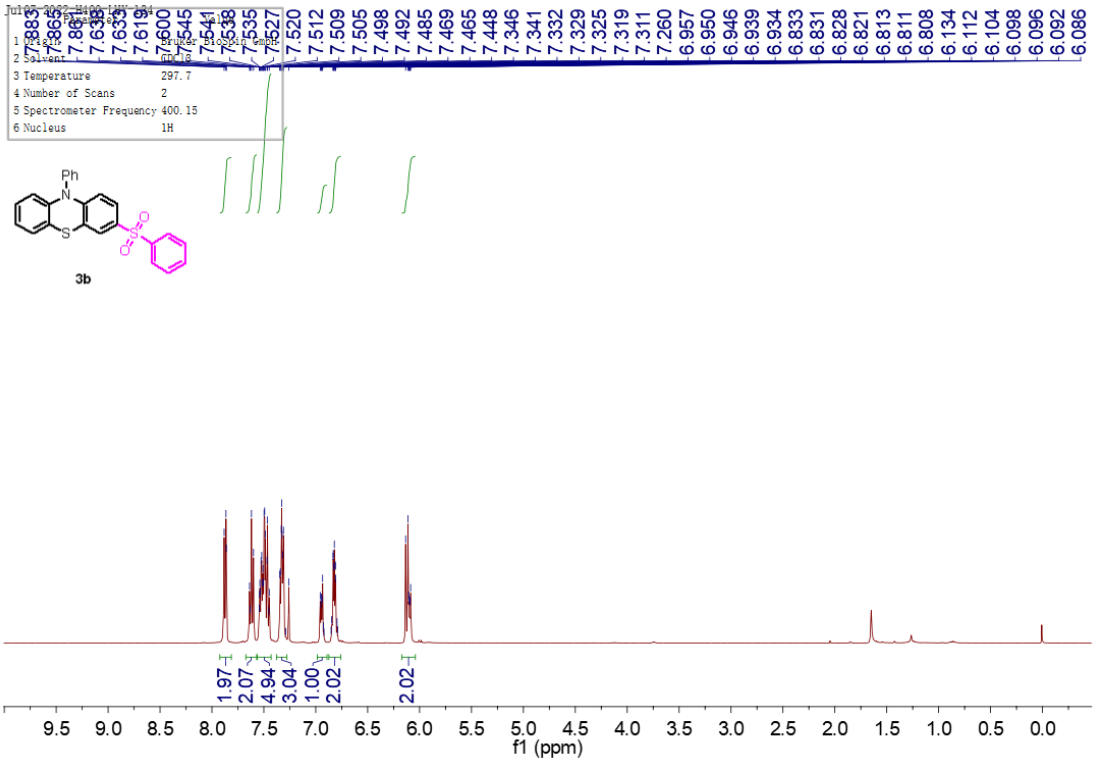


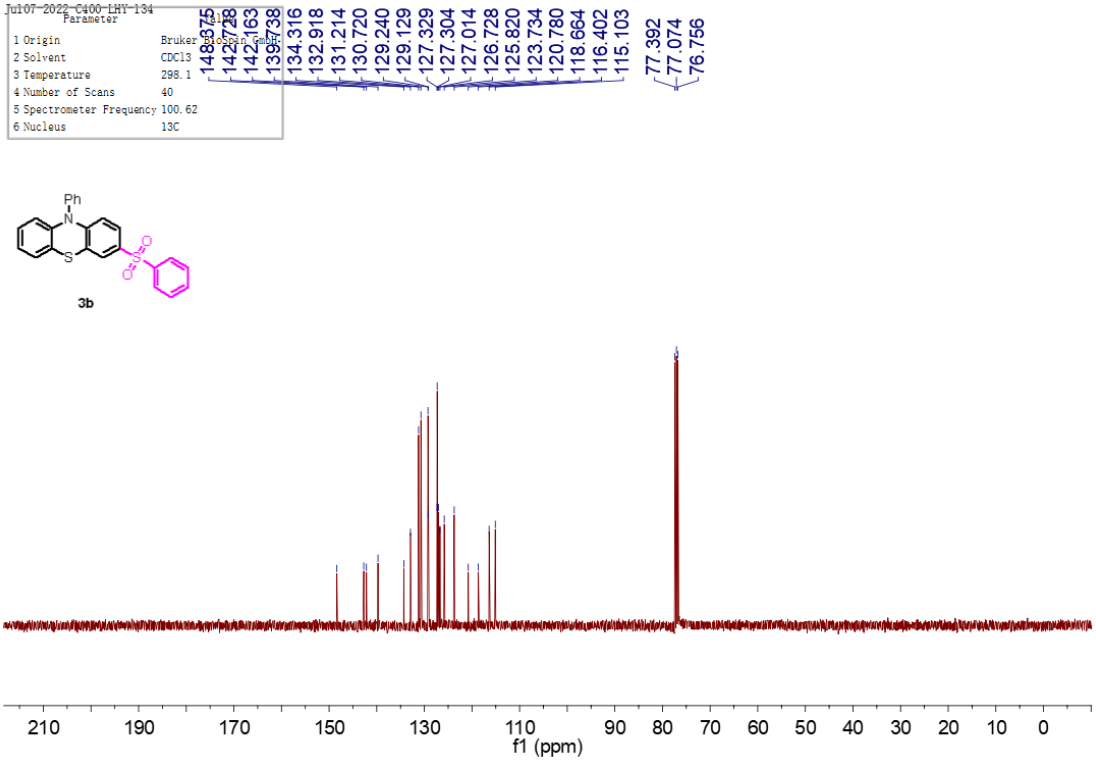
Figure S9 Absorption spectroscopy of **1a**, **2a** and the mixture of **1a** and **2a** in MeCN, and emission spectroscopy of 30 W blue LED.

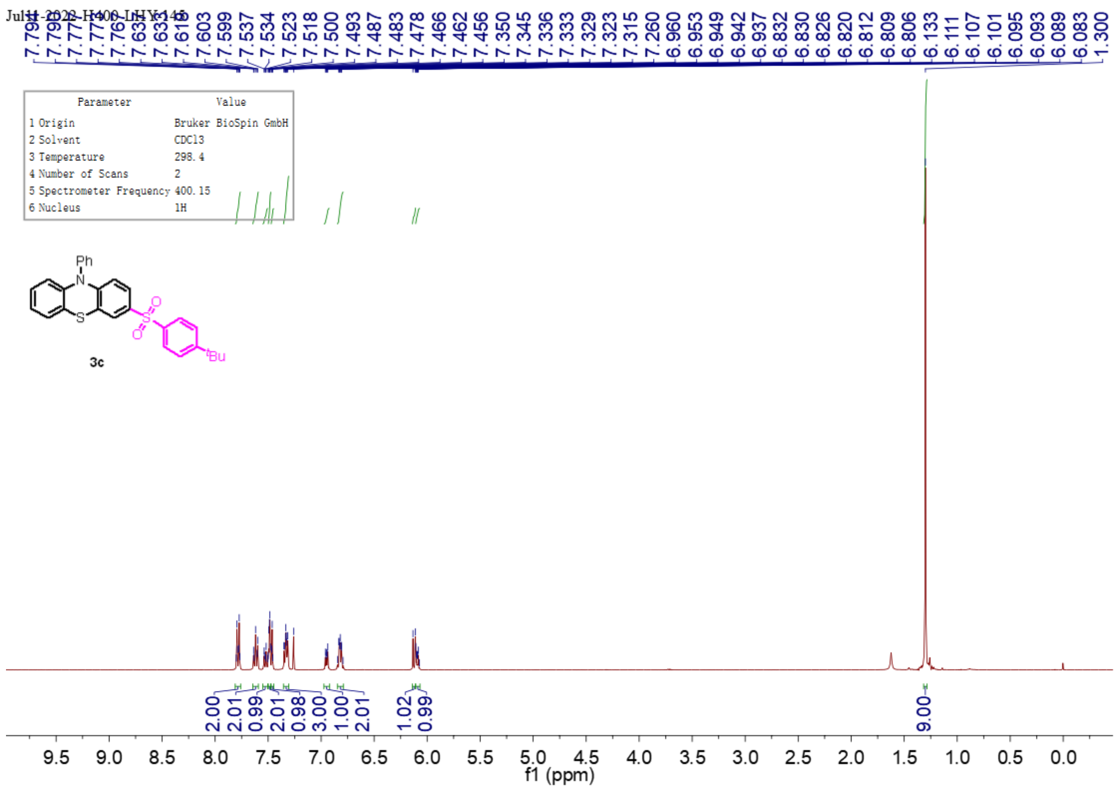
7. NMR spectra



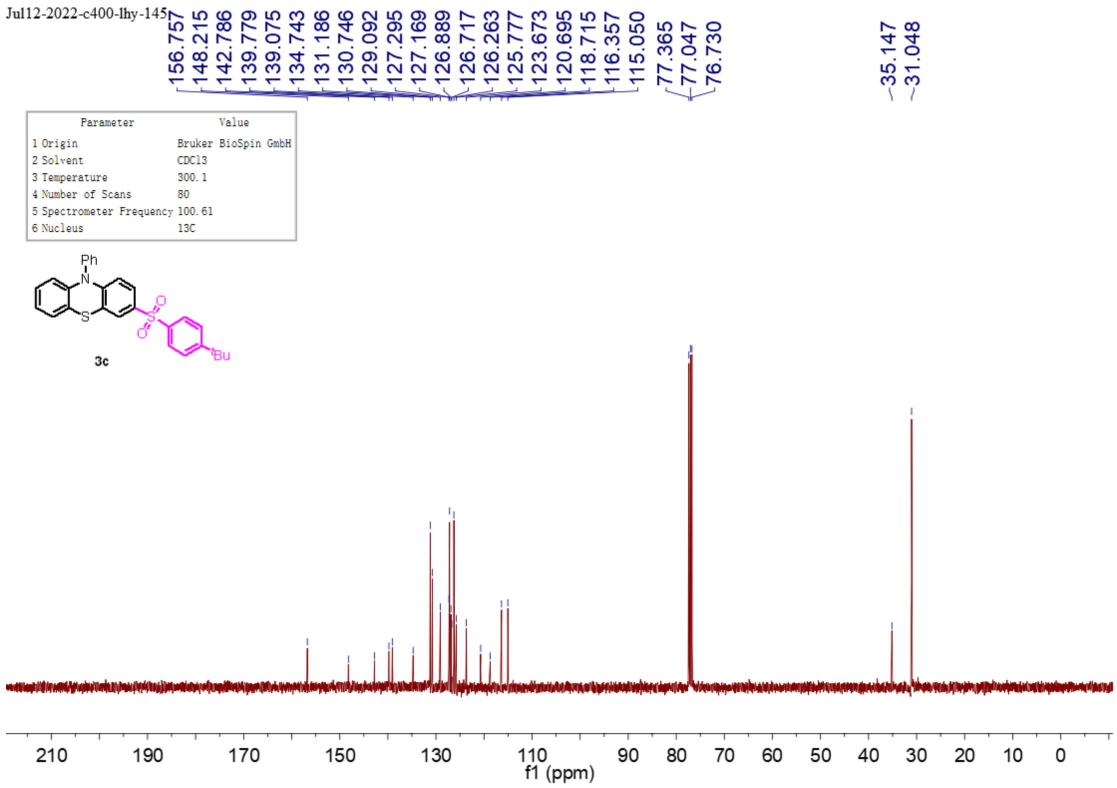



Jul07-2022-C400-LHY-134
Parameter
1 Origin Bruker Biospin GmbH
2 Solvent CDCl3
3 Temperature 297.7
4 Number of Scans 2
5 Spectrometer Frequency 400.15
6 Nucleus 1H
7.883 7.865 7.638 7.635 7.619 7.600 7.545 7.541 7.538 7.535 7.527 7.520 7.512 7.509 7.505 7.498 7.492 7.485 7.469 7.465 7.448 7.346 7.341 7.332 7.329 7.325 7.319 7.311 7.260 6.957 6.950 6.946 6.939 6.934 6.833 6.831 6.828 6.821 6.813 6.811 6.808 6.134 6.112 6.104 6.098 6.096 6.092 6.086
Ph
N
S
O
O
S
3b
1.97
2.07
4.94
3.04
1.00
2.02
2.02
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)

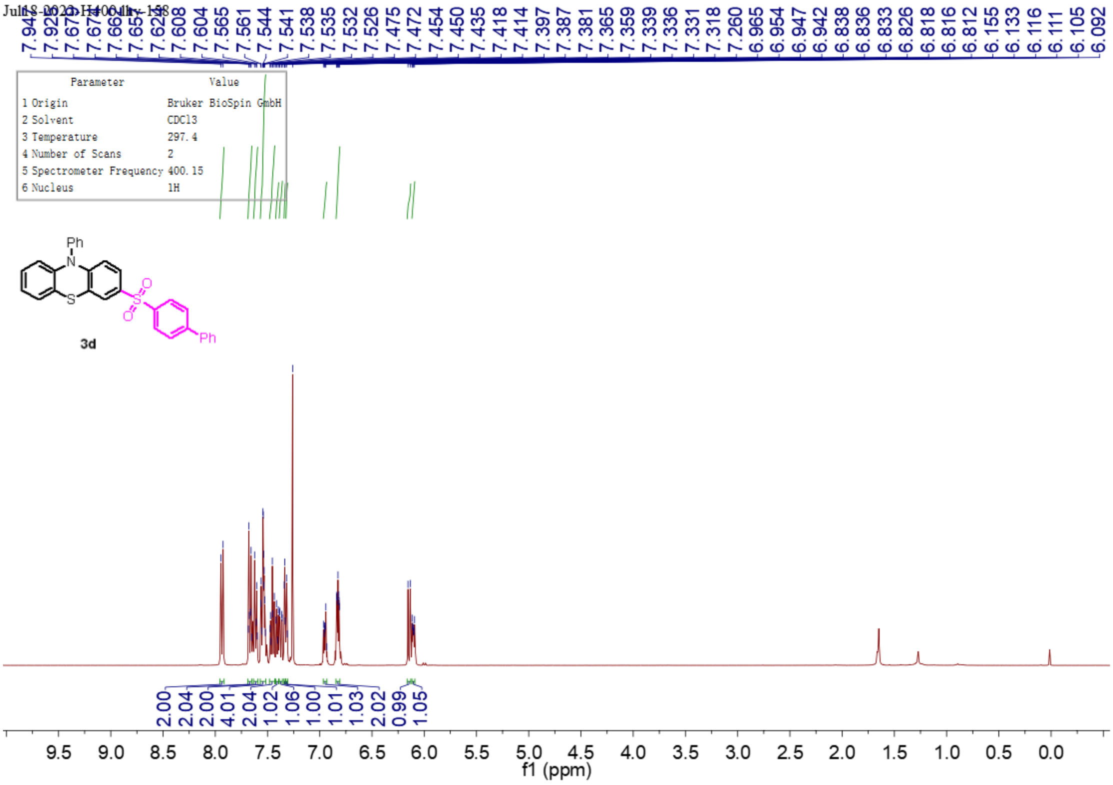

Jul07-2022-C400-LHY-134
Parameter
1 Origin Bruker Biospin GmbH
2 Solvent CDCl3
3 Temperature 298.1
4 Number of Scans 40
5 Spectrometer Frequency 100.62
6 Nucleus 13C
148.975 142.728 142.163 139.738 134.316 132.918 131.214 130.720 129.240 129.129 127.329 127.304 127.014 126.728 125.820 123.734 120.780 118.664 116.402 115.103 77.392 77.074 76.756
Ph
N
S
O
O
S
3b
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

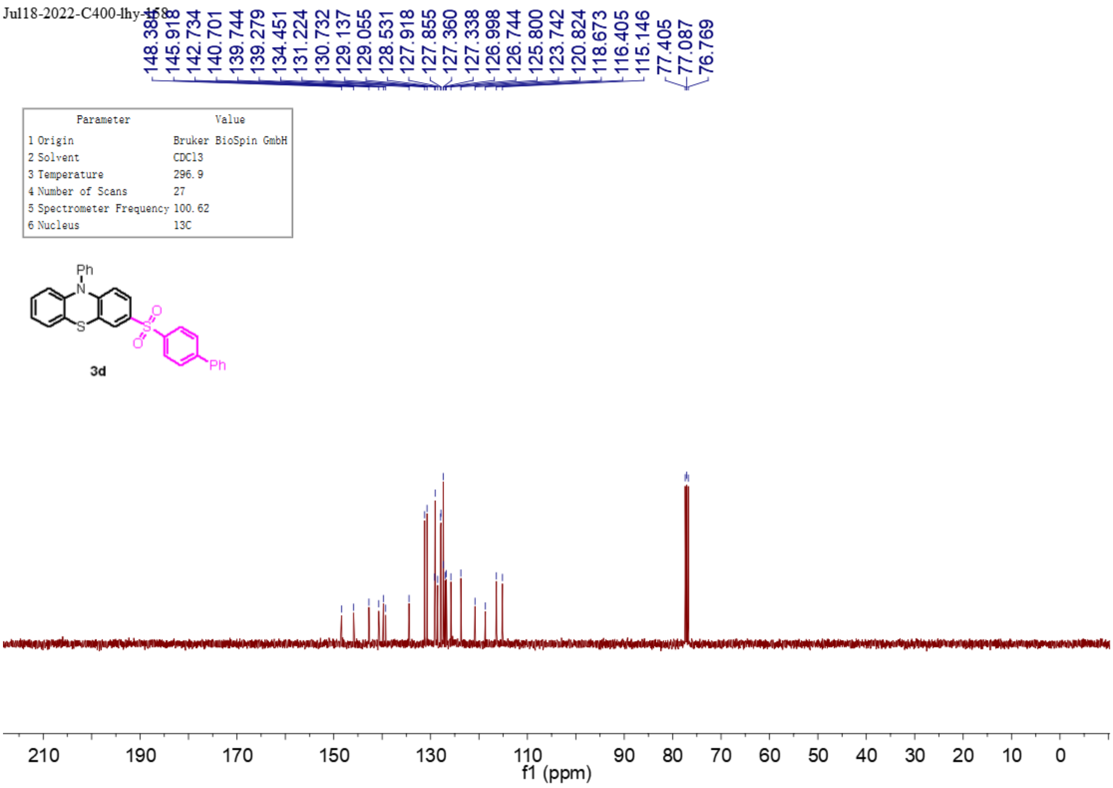


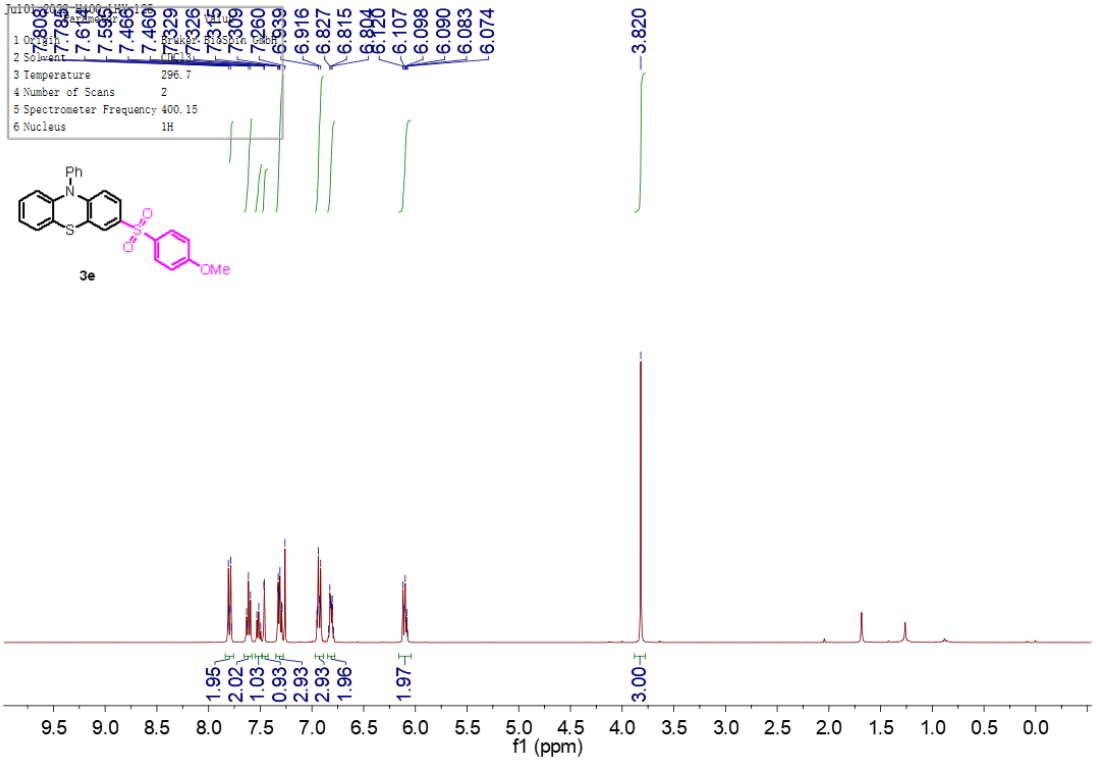
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.4
4 Number of Scans 2
5 Spectrometer Frequency 400.15
6 Nucleus 1H
7.603 7.599 7.537 7.534 7.523 7.518 7.500 7.493 7.487 7.483 7.478 7.466 7.462 7.456 7.350 7.345 7.336 7.333 7.329 7.323 7.315 7.260 6.960 6.953 6.949 6.942 6.937 6.832 6.830 6.826 6.820 6.812 6.809 6.806 6.133 6.111 6.107 6.101 6.095 6.093 6.089 6.083 1.300
Ph
N
S
O
O
tBu
3c
2.00 2.01 0.99 2.01 0.98 3.00 1.00 2.01 1.02 0.99 9.00
f1 (ppm)

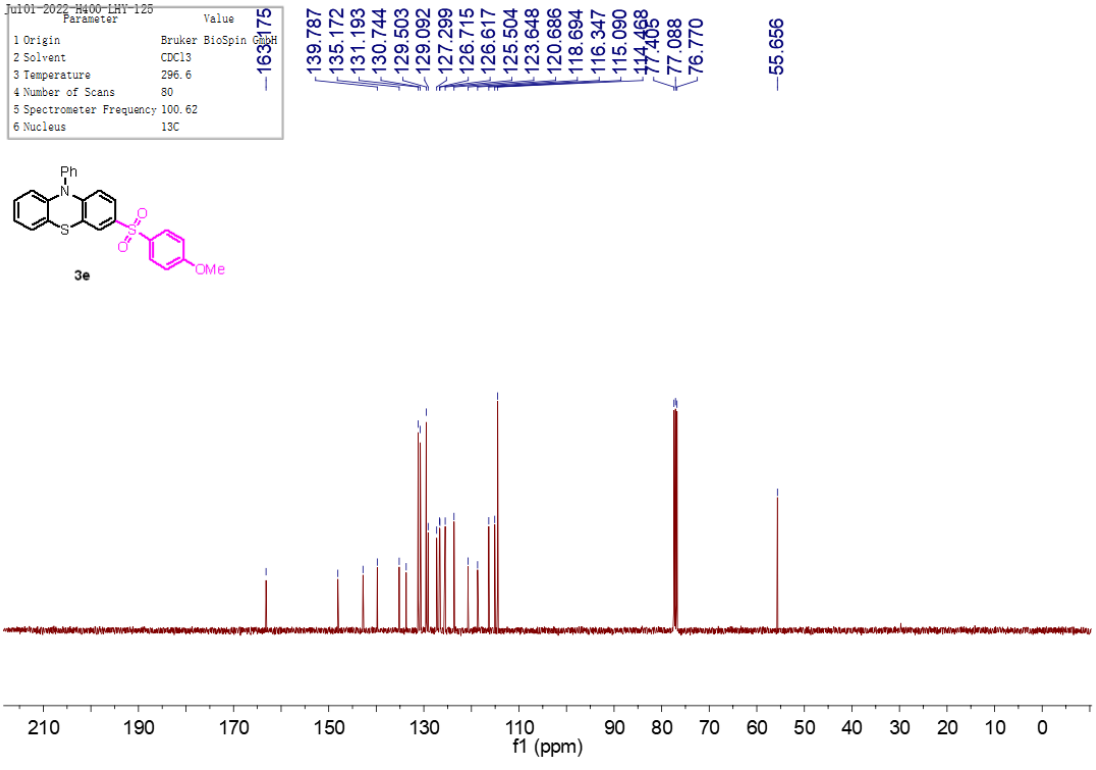


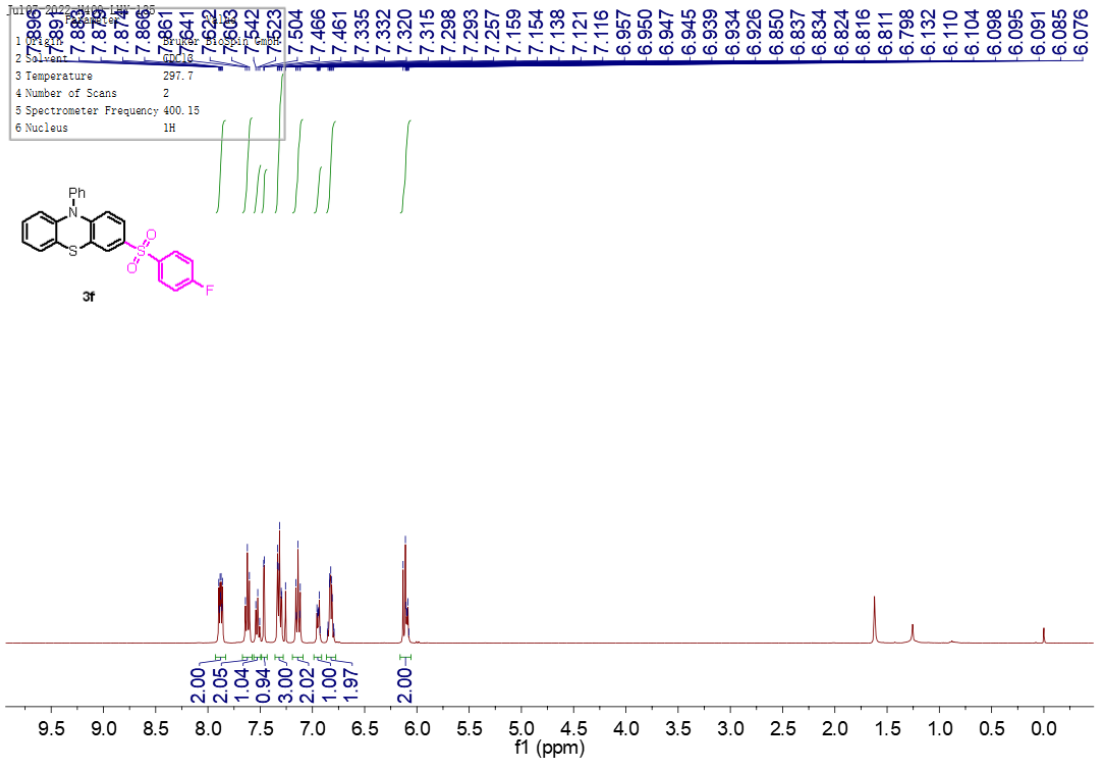
Jul12-2022-c400-lhy-145
156.757 148.215 142.786 139.779 139.075 134.743 131.186 130.746 129.092 127.295 127.169 126.889 126.717 126.263 125.777 123.673 120.695 118.715 116.357 115.050 77.365 77.047 76.730 35.147 31.048
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 300.1
4 Number of Scans 80
5 Spectrometer Frequency 100.61
6 Nucleus 13C
Ph
N
S
O
O
tBu
3c
f1 (ppm)

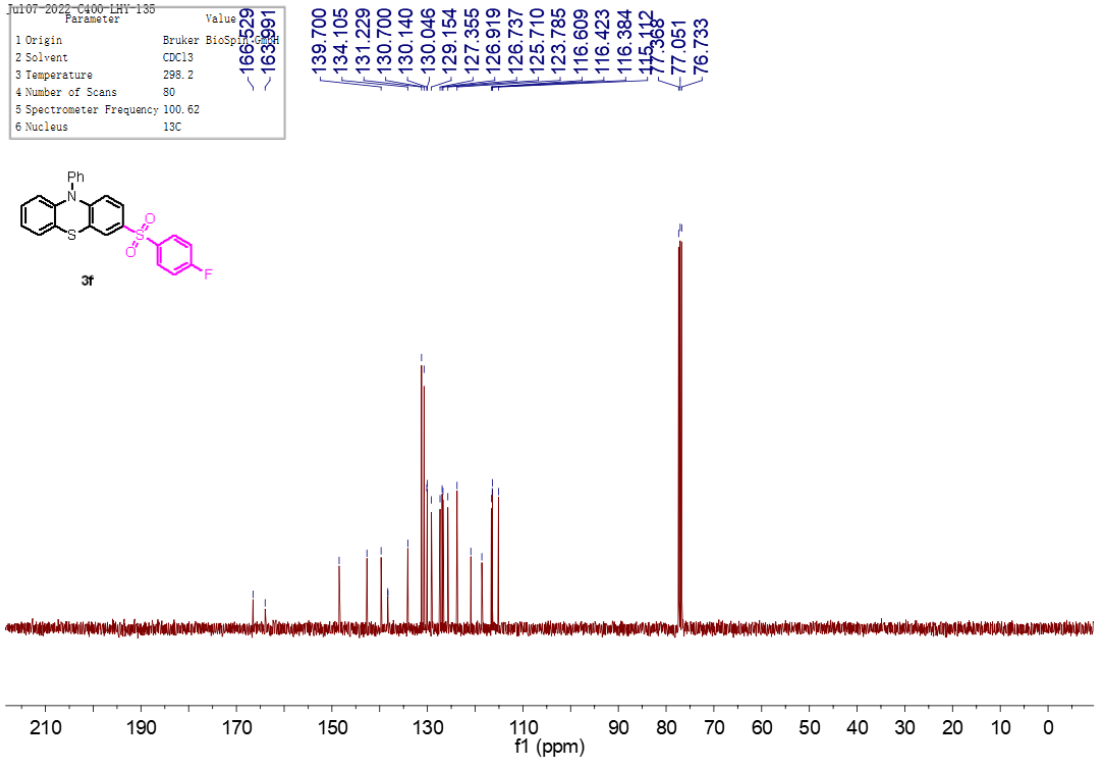

Jul18-2022-H400-lhy-158
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 297.4
4 Number of Scans 2
5 Spectrometer Frequency 400.15
6 Nucleus 1H
Ph
N
S
O
O
Ph
3d
2.00 2.04 2.00 4.01 2.04 1.02 1.06 1.00 1.01 1.03 2.02 0.99 1.05
f1 (ppm)

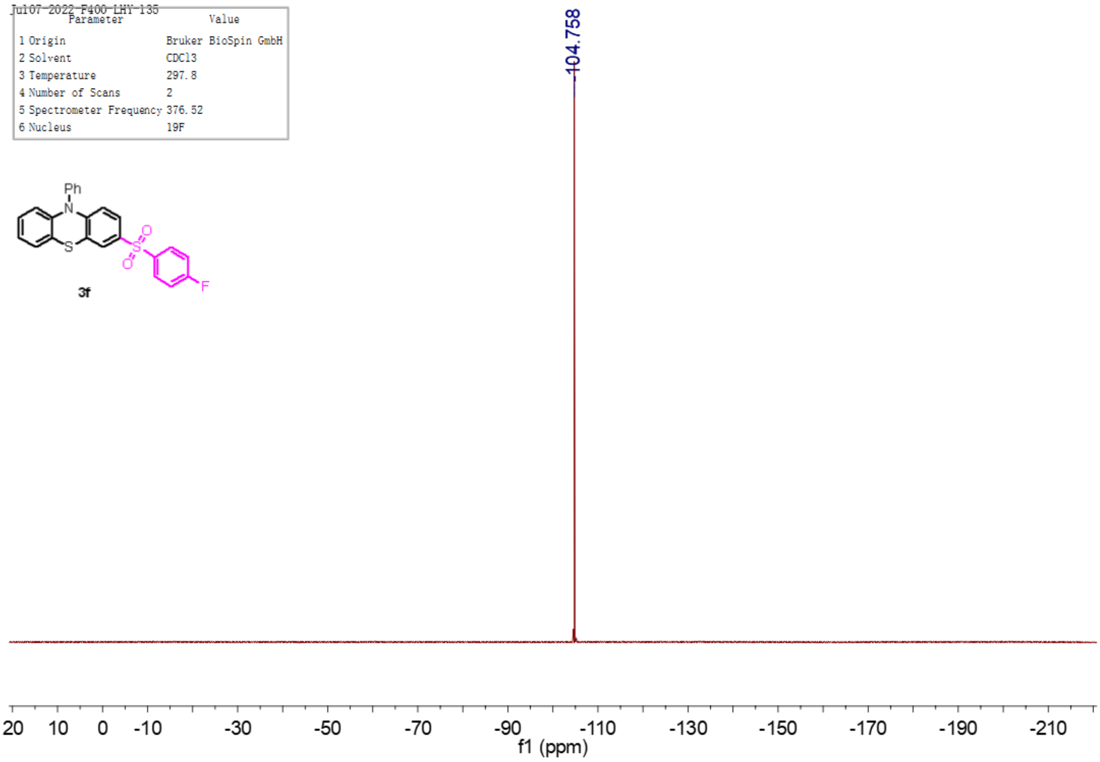

Jul18-2022-C400-lhy-158
148.385 145.918 142.734 140.701 139.744 139.279 134.451 131.224 130.732 129.137 129.055 128.531 127.918 127.855 127.360 127.338 126.998 126.744 125.800 123.742 120.824 118.673 116.405 115.146 77.405 77.087 76.769
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 296.9
4 Number of Scans 27
5 Spectrometer Frequency 100.62
6 Nucleus 13C
Ph
N
S
O
O
Ph
3d
f1 (ppm)

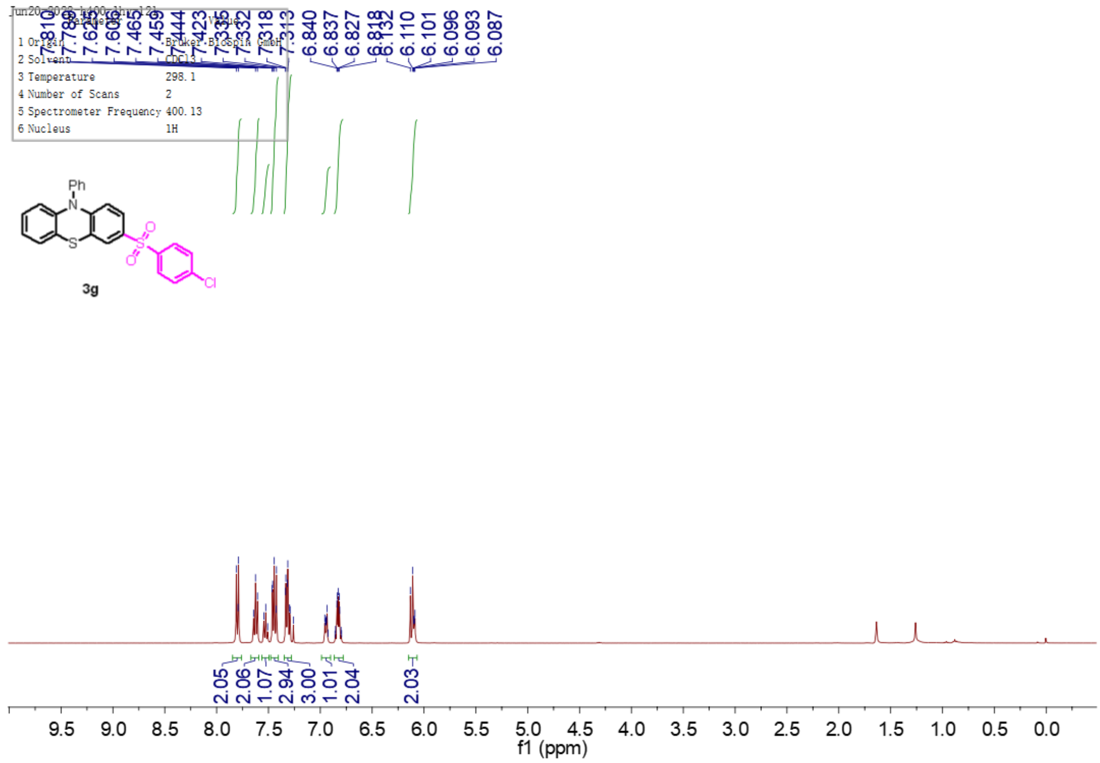

Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 296.7
4 Number of Scans 2
5 Spectrometer Frequency 400.15
6 Nucleus 1H
7.808
7.784
7.614
7.593
7.460
7.329
7.326
7.315
7.309
6.939
6.916
6.827
6.815
6.804
6.120
6.107
6.098
6.090
6.083
6.074
3.820
Ph
N
S
O
O
OMe
3e
1.95
2.02
1.03
0.93
2.93
2.93
1.96
1.97
3.00
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)

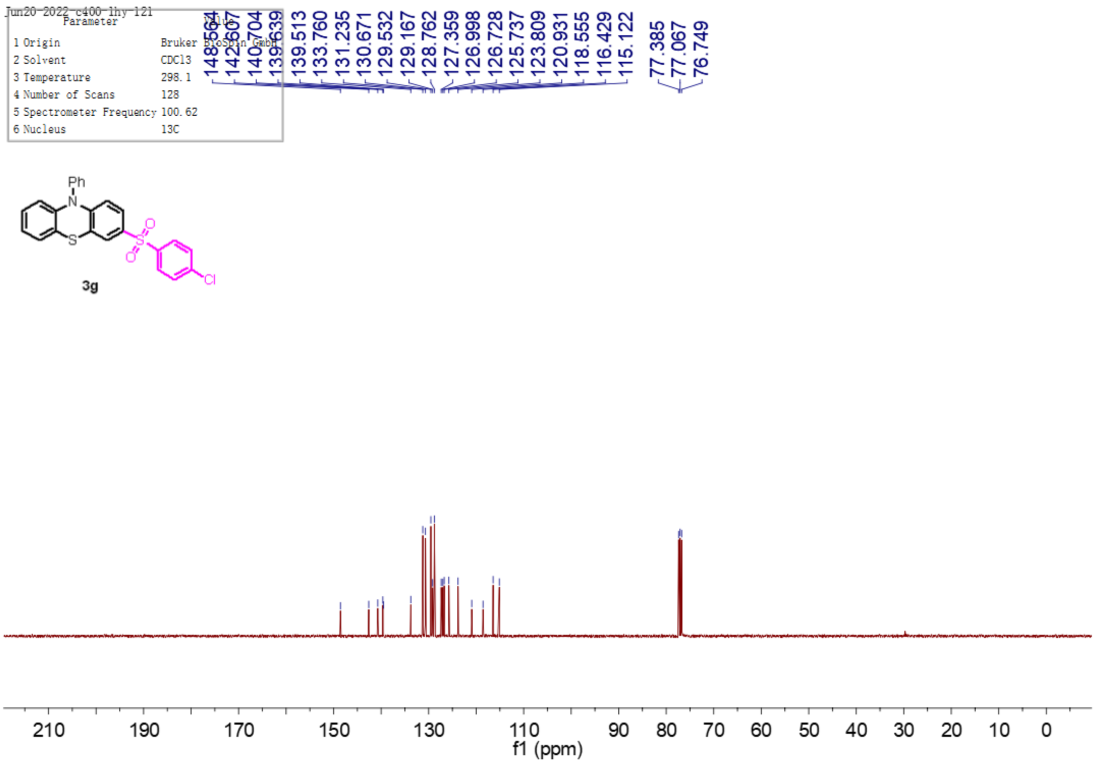

Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 296.6
4 Number of Scans 80
5 Spectrometer Frequency 100.62
6 Nucleus 13C
163.175
139.787
135.172
131.193
130.744
129.503
129.092
127.299
126.715
126.617
125.504
123.648
120.686
118.694
116.347
115.090
114.468
77.405
77.088
76.770
55.656
Ph
N
S
O
O
OMe
3e
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

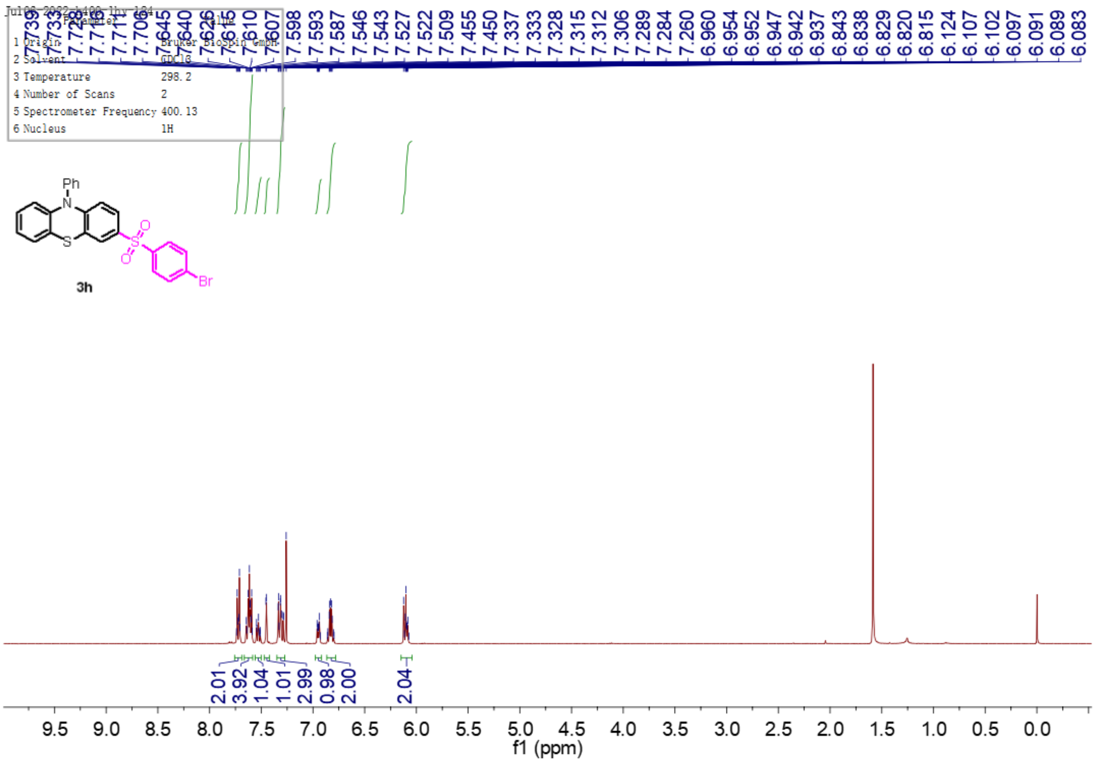

Jul05-2022-C400-LHY-135
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 297.7
4 Number of Scans 2
5 Spectrometer Frequency 400.15
6 Nucleus 1H
7.896 7.891 7.885 7.874 7.869 7.861 7.641 7.622 7.603 7.542 7.523 7.504 7.466 7.461 7.335 7.332 7.320 7.315 7.298 7.293 7.257 7.159 7.154 7.138 7.121 7.116 6.957 6.950 6.947 6.945 6.939 6.934 6.926 6.850 6.837 6.834 6.824 6.816 6.811 6.798 6.132 6.110 6.104 6.098 6.095 6.091 6.085 6.076
Ph
N
S
O
O
S
F
3f
2.00 2.05 1.04 0.94 3.00 2.02 1.00 1.97 2.00
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)

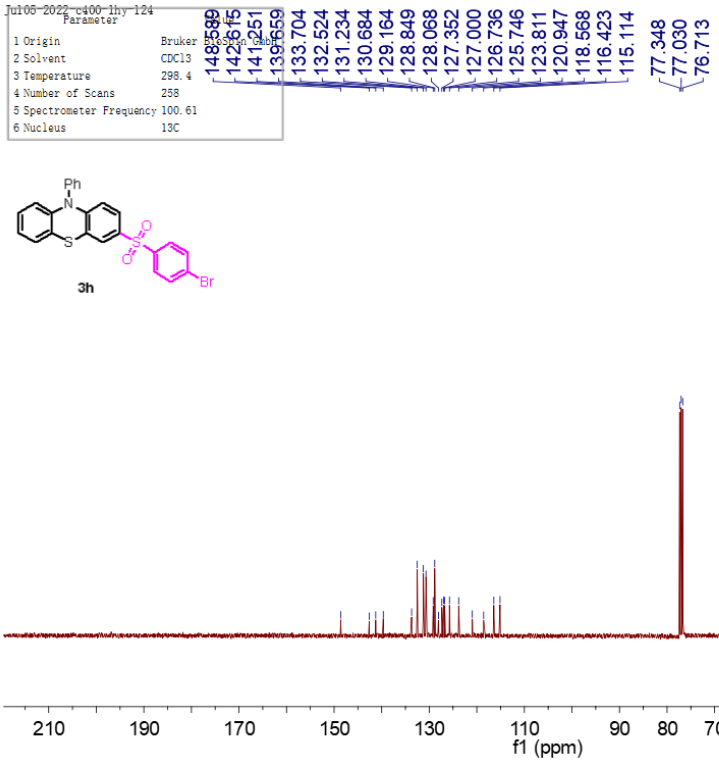

Jul07-2022-C400-LHY-135
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 80
5 Spectrometer Frequency 100.62
6 Nucleus 13C
166.529
163.991
139.700 134.105 131.229 130.700 130.140 130.046 129.154 127.355 126.919 126.737 125.710 123.785 116.609 116.423 116.384 115.112 77.368 77.051 76.733
Ph
N
S
O
O
S
F
3f
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

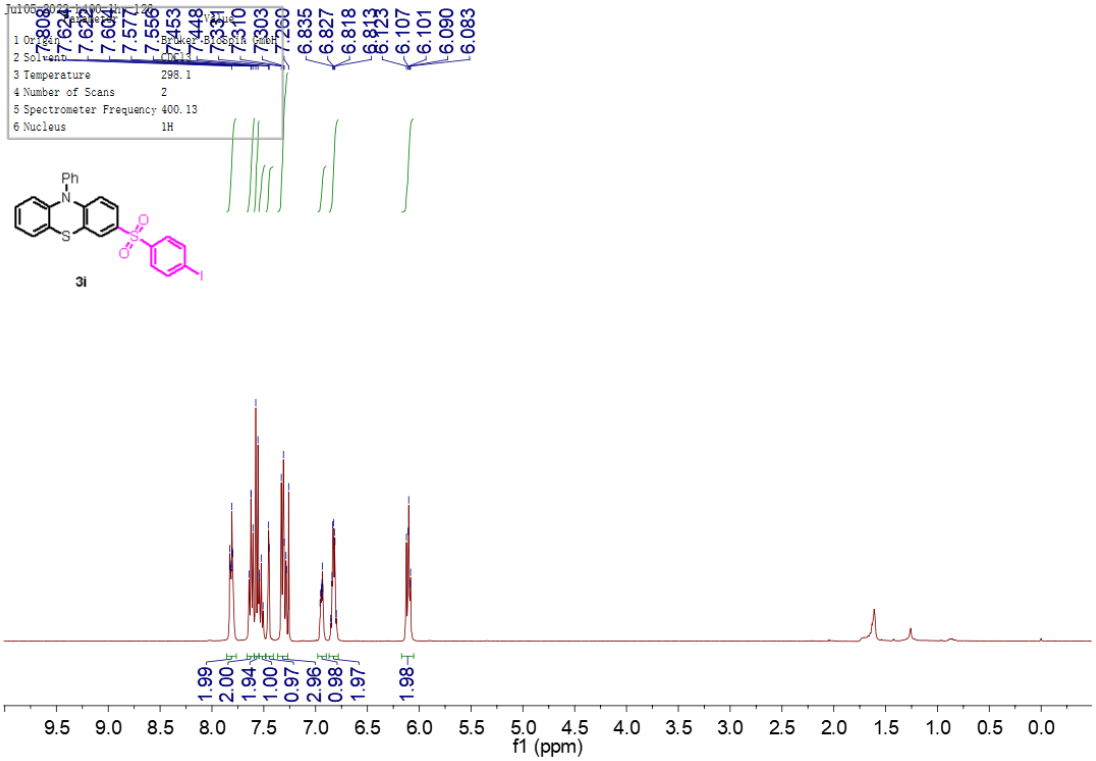

Jul07-2022-F400-LHY-135
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 297.8
4 Number of Scans 2
5 Spectrometer Frequency 376.52
6 Nucleus 19F
-104.758
Ph
N
S
O
O
F
3f
f1 (ppm)

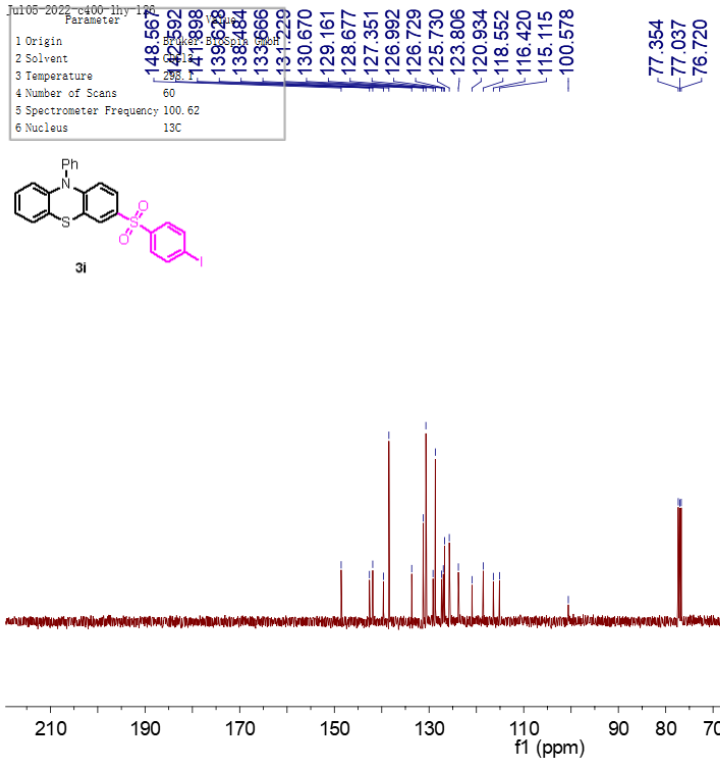

Jun20-2022-H400-LHY-131
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.1
4 Number of Scans 2
5 Spectrometer Frequency 400.13
6 Nucleus 1H
7.810
7.789
7.625
7.606
7.465
7.459
7.444
7.423
7.335
7.332
7.318
7.313
6.840
6.837
6.827
6.818
6.132
6.110
6.101
6.096
6.093
6.087
Ph
N
S
O
O
Cl
3g
2.05
2.06
1.07
2.94
3.00
1.01
2.04
2.03
f1 (ppm)

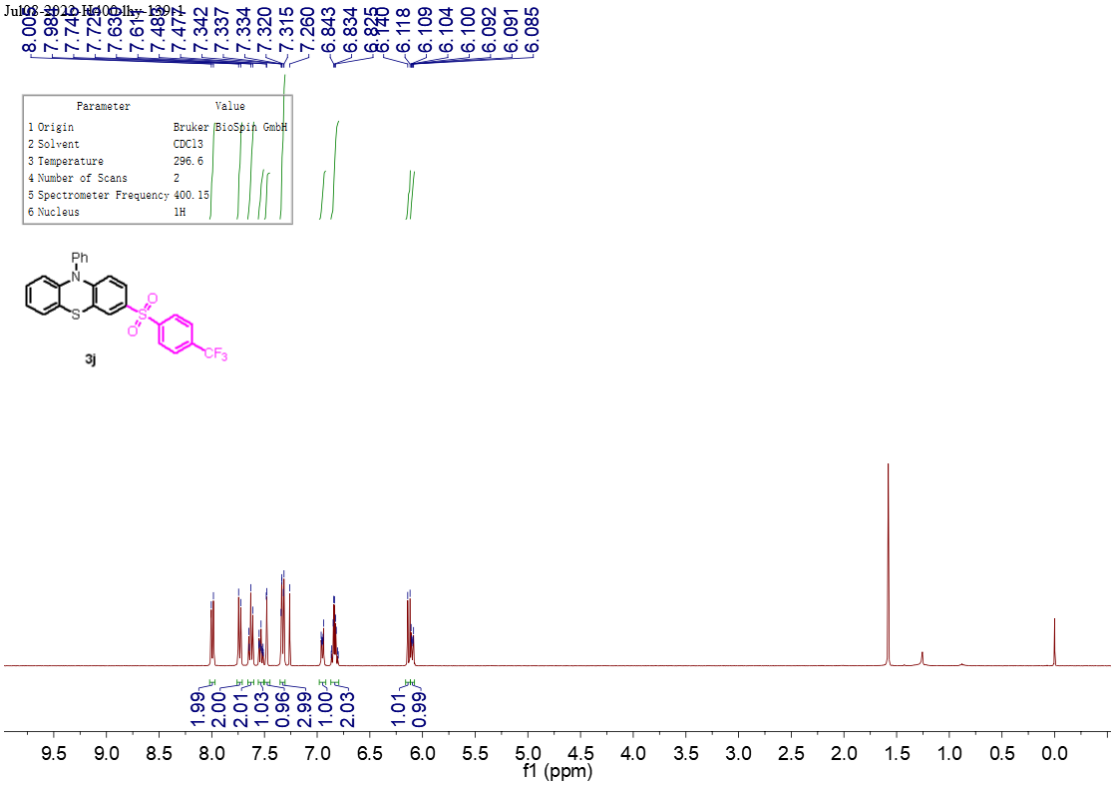

Jun20-2022-c400-lhy-121
Parameter
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.1
4 Number of Scans 128
5 Spectrometer Frequency 100.62
6 Nucleus 13C
148.564
142.607
140.704
139.639
139.513
133.760
131.235
130.671
129.532
129.167
128.762
127.359
126.998
126.728
125.737
123.809
120.931
118.555
116.429
115.122
77.385
77.067
76.749
Ph
N
S
O
O
Cl
3g
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

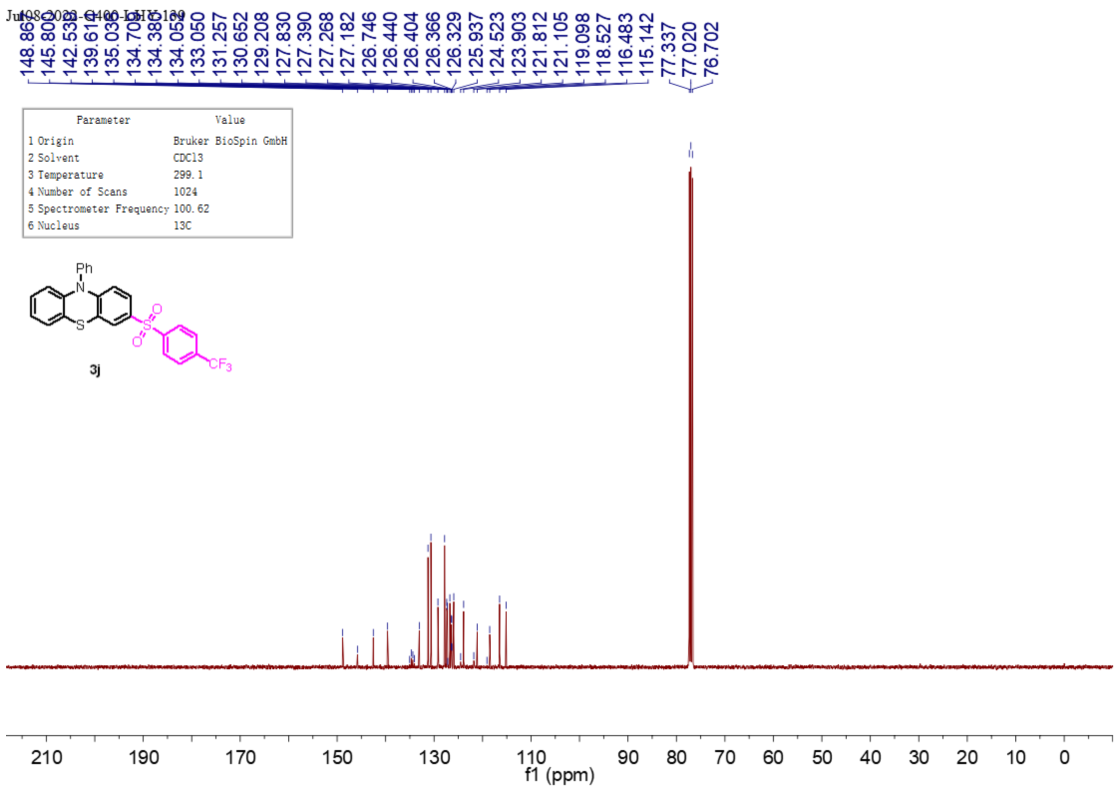

3 Temperature 298.2
4 Number of Scans 2
5 Spectrometer Frequency 400.13
6 Nucleus 1H
7.706
7.645
7.640
7.626
7.615
7.610
7.607
7.598
7.593
7.587
7.546
7.543
7.527
7.522
7.509
7.455
7.450
7.337
7.333
7.328
7.315
7.312
7.306
7.289
7.284
7.260
6.960
6.954
6.952
6.947
6.942
6.937
6.843
6.838
6.829
6.820
6.815
6.124
6.107
6.102
6.097
6.091
6.089
6.083
Ph
N
S
O
O
Br
3h
2.01
3.92
1.04
1.01
2.99
0.98
2.00
2.04
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)

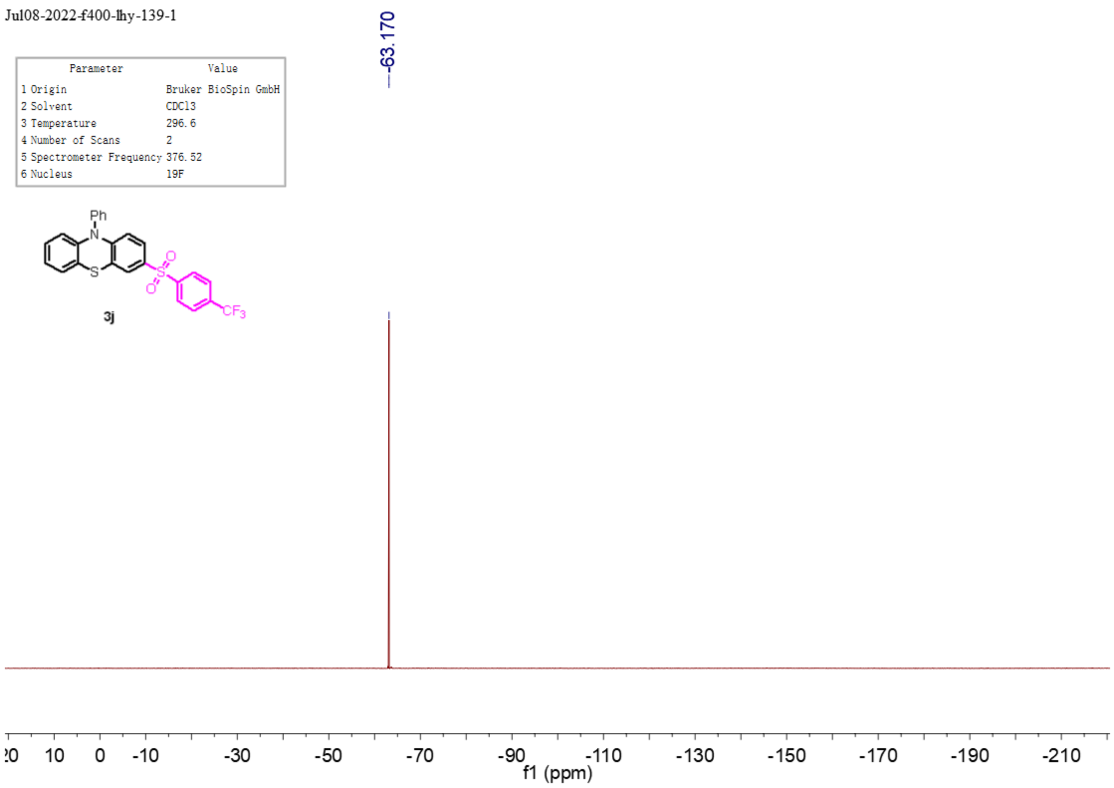

Jul05-2022-c400-lhy-124
Parameter
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.4
4 Number of Scans 258
5 Spectrometer Frequency 100.61
6 Nucleus 13C
148.589
142.615
141.251
139.659
133.704
132.524
131.234
130.684
129.164
128.849
128.068
127.352
127.000
126.736
125.746
123.811
120.947
118.568
116.423
115.114
77.348
77.030
76.713
Ph
N
S
O
O
Br
3h
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

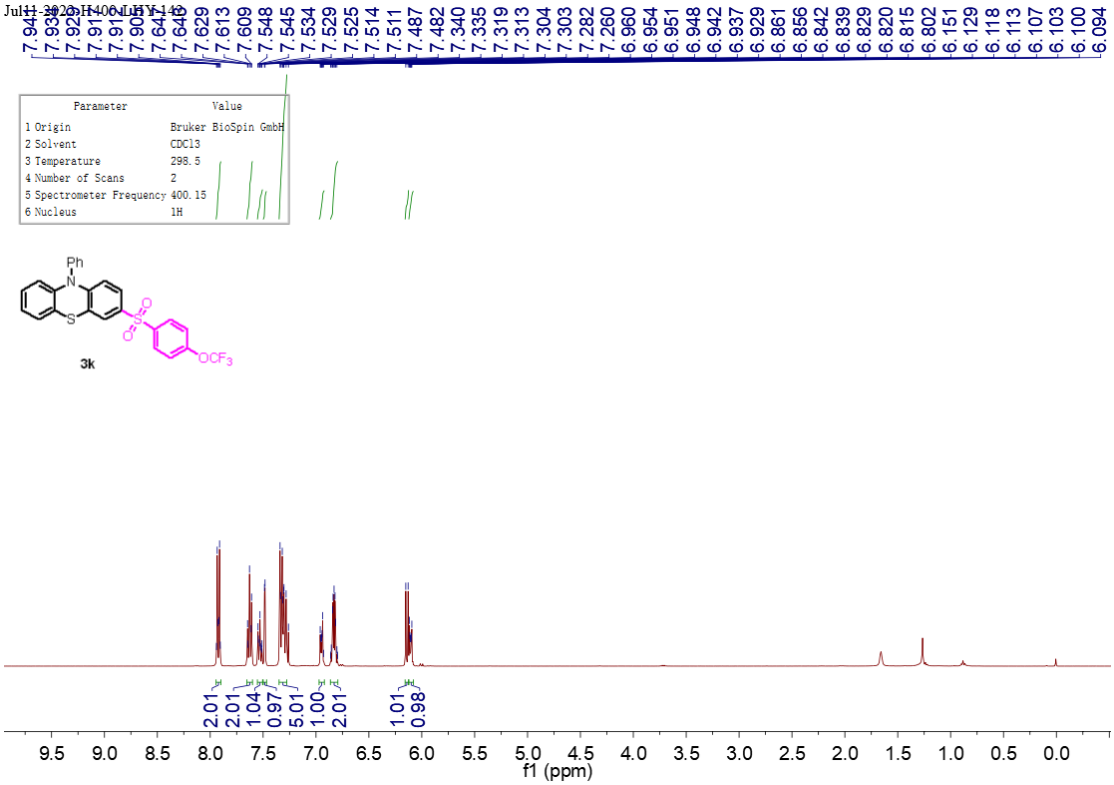

7.908
7.624
7.622
7.604
7.577
7.556
7.453
7.448
7.331
7.310
7.303
7.260
6.835
6.827
6.818
6.813
6.123
6.107
6.101
6.090
6.083
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.1
4 Number of Scans 2
5 Spectrometer Frequency 400.13
6 Nucleus 1H
Ph
N
S
O
O
I
3i
1.99
2.00
1.94
1.00
0.97
2.96
0.98
1.97
1.98
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)

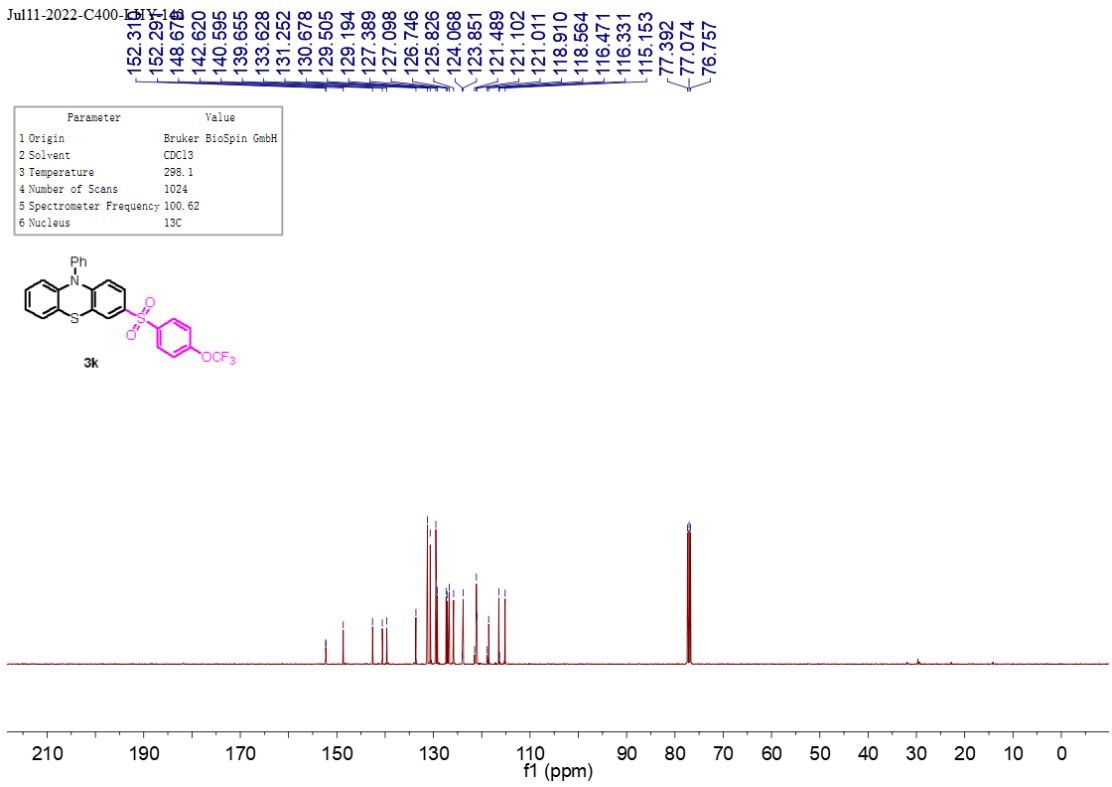

Jul05-2022-c400-lhy-13C
Parameter
1 Origin
2 Solvent
3 Temperature
4 Number of Scans 60
5 Spectrometer Frequency 100.62
6 Nucleus 13C
148.567
142.592
141.898
139.628
138.484
133.666
131.229
130.670
129.161
128.677
127.351
126.992
126.729
125.730
123.806
120.934
118.552
116.420
115.115
100.578
77.354
77.037
76.720
Ph
N
S
O
O
I
3i
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


8.008
7.988
7.744
7.722
7.634
7.614
7.488
7.477
7.342
7.337
7.334
7.320
7.315
7.260
6.843
6.834
6.825
6.140
6.118
6.109
6.104
6.100
6.092
6.091
6.085
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 296.6
4 Number of Scans 2
5 Spectrometer Frequency 400.15
6 Nucleus 1H
Ph
N
S
O
O
CF3
3j
1.99
2.00
2.01
1.03
0.96
2.99
1.00
2.03
1.01
0.99
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)


148.865
145.800
142.538
139.612
135.036
134.708
134.380
134.053
133.050
131.257
130.652
129.208
127.830
127.390
127.268
127.182
126.746
126.440
126.404
126.366
126.329
125.937
124.523
123.903
121.812
121.105
119.098
118.527
116.483
115.142
77.337
77.020
76.702
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 299.1
4 Number of Scans 1024
5 Spectrometer Frequency 100.62
6 Nucleus 13C
Ph
N
S
O
S
O
CF3
3j
f1 (ppm)

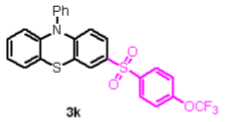

Jul08-2022-f400-lhy-139-1
-63.170
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 296.6
4 Number of Scans 2
5 Spectrometer Frequency 376.52
6 Nucleus 19F
Ph
N
S
O
S
O
CF3
3j
f1 (ppm)


Jul11-2022-H400-LHY-142
7.948
7.934
7.925
7.916
7.912
7.905
7.645
7.640
7.629
7.613
7.609
7.548
7.545
7.534
7.529
7.525
7.514
7.511
7.487
7.482
7.340
7.335
7.319
7.313
7.304
7.303
7.282
7.260
6.960
6.954
6.951
6.948
6.942
6.937
6.929
6.861
6.856
6.842
6.839
6.829
6.820
6.815
6.802
6.151
6.129
6.118
6.113
6.107
6.103
6.100
6.094
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.5
4 Number of Scans 2
5 Spectrometer Frequency 400.15
6 Nucleus 1H
Ph
N
S
O
O
S
OCF3
3k
2.01
2.01
1.04
0.97
5.01
1.00
2.01
1.01
0.98
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)

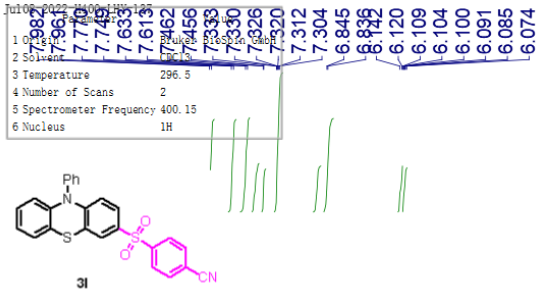

Jul11-2022-C400-LHY-142
152.315
152.297
148.678
142.620
140.595
139.655
133.628
131.252
130.678
129.505
129.194
127.389
127.098
126.746
125.826
124.068
123.851
121.489
121.102
121.011
118.910
118.564
116.471
116.331
115.153
77.392
77.074
76.757
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.1
4 Number of Scans 1024
5 Spectrometer Frequency 100.62
6 Nucleus 13C
Ph
N
S
O
O
S
OCF3
3k
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

Jul11-2022-F400-LHY-142

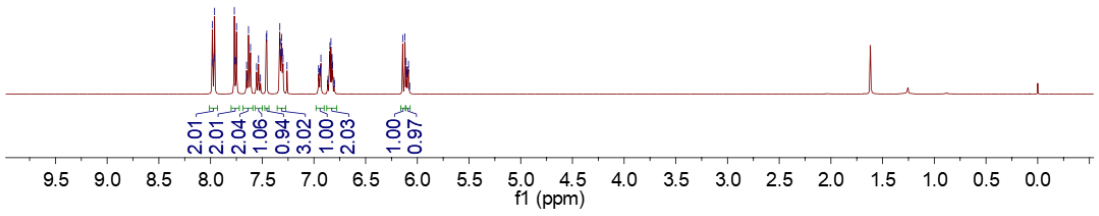
Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	298.5
4 Number of Scans	2
5 Spectrometer Frequency	376.52
6 Nucleus	19F

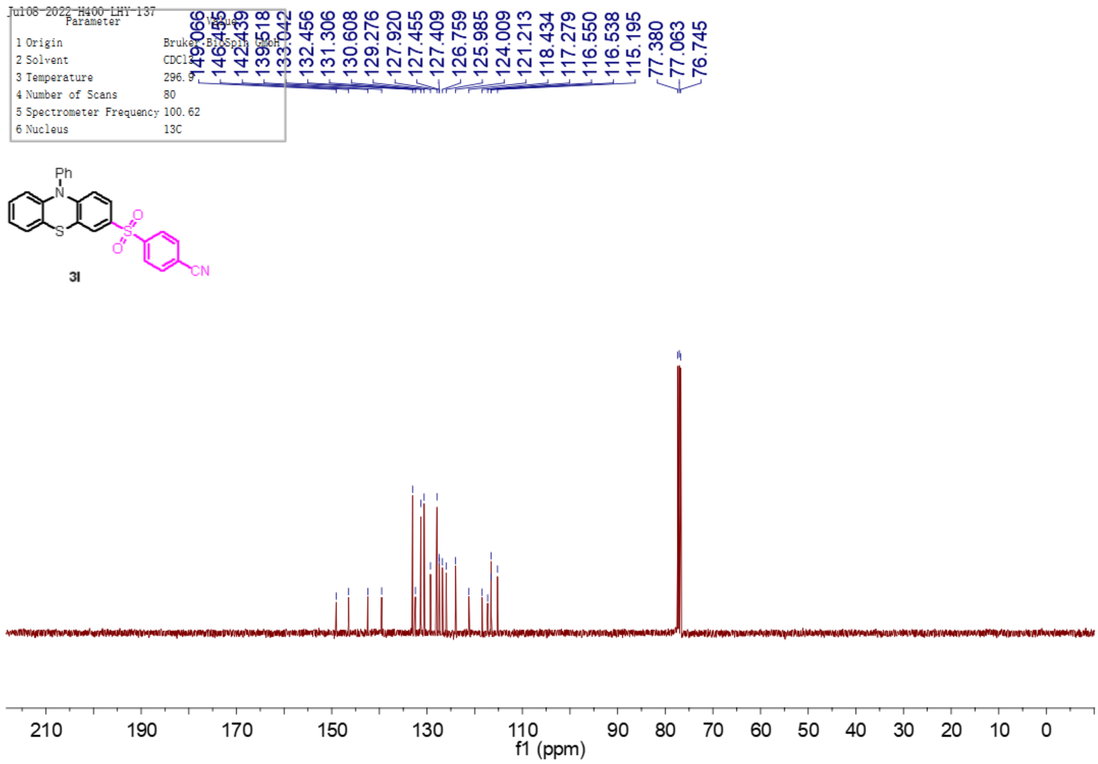


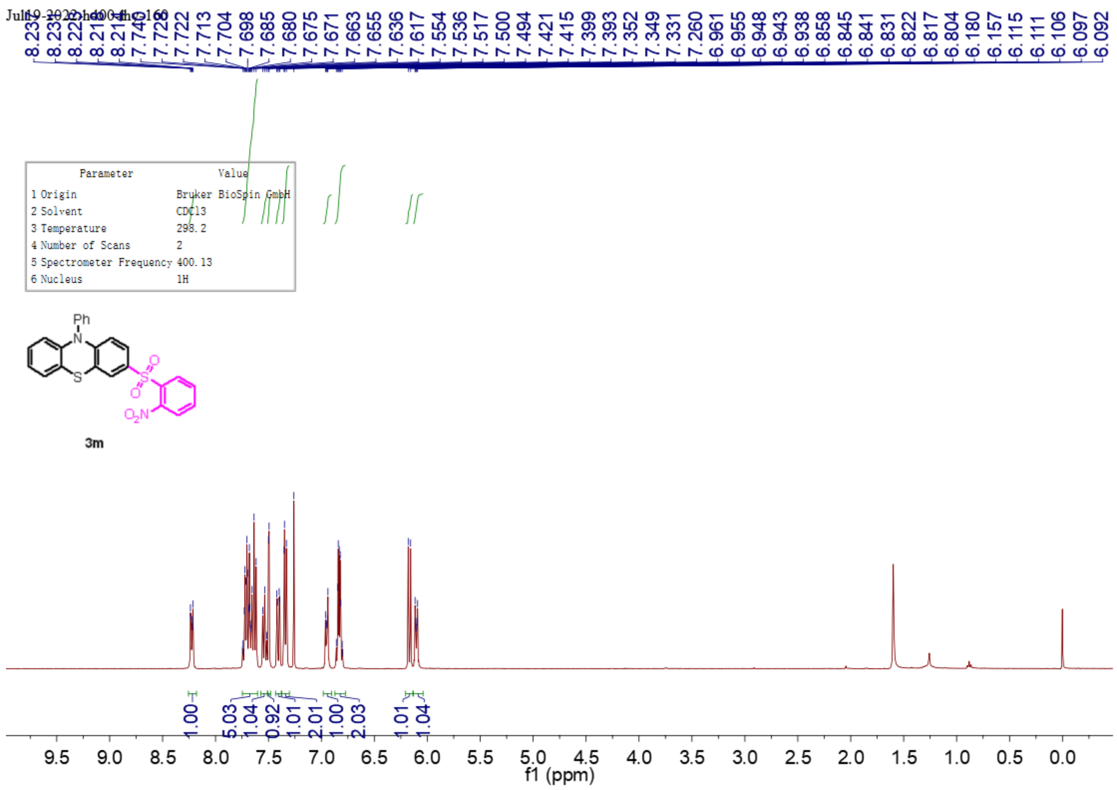
3k

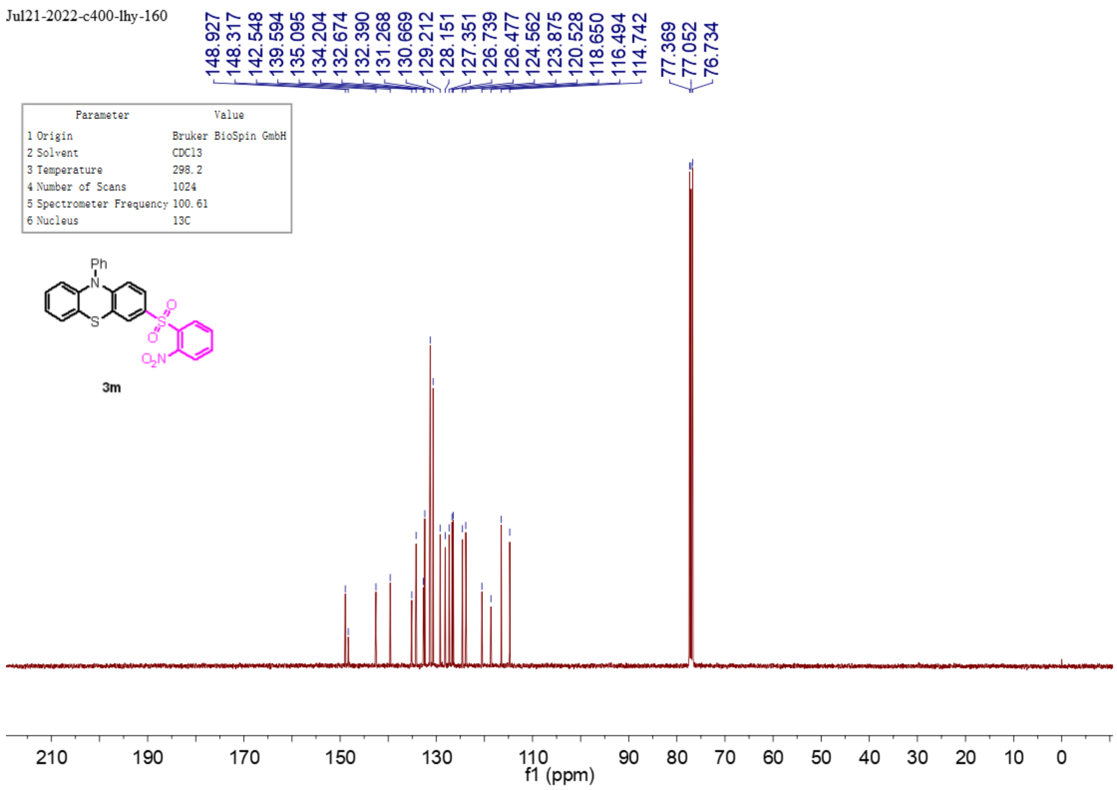


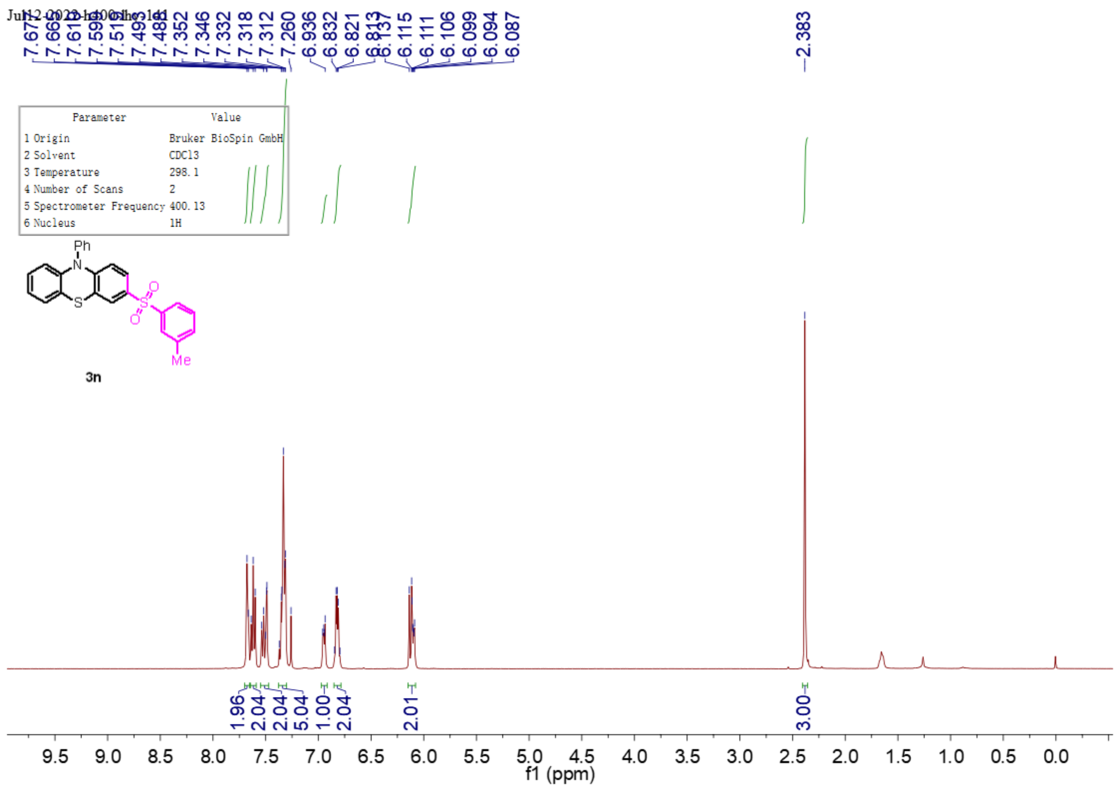
3l

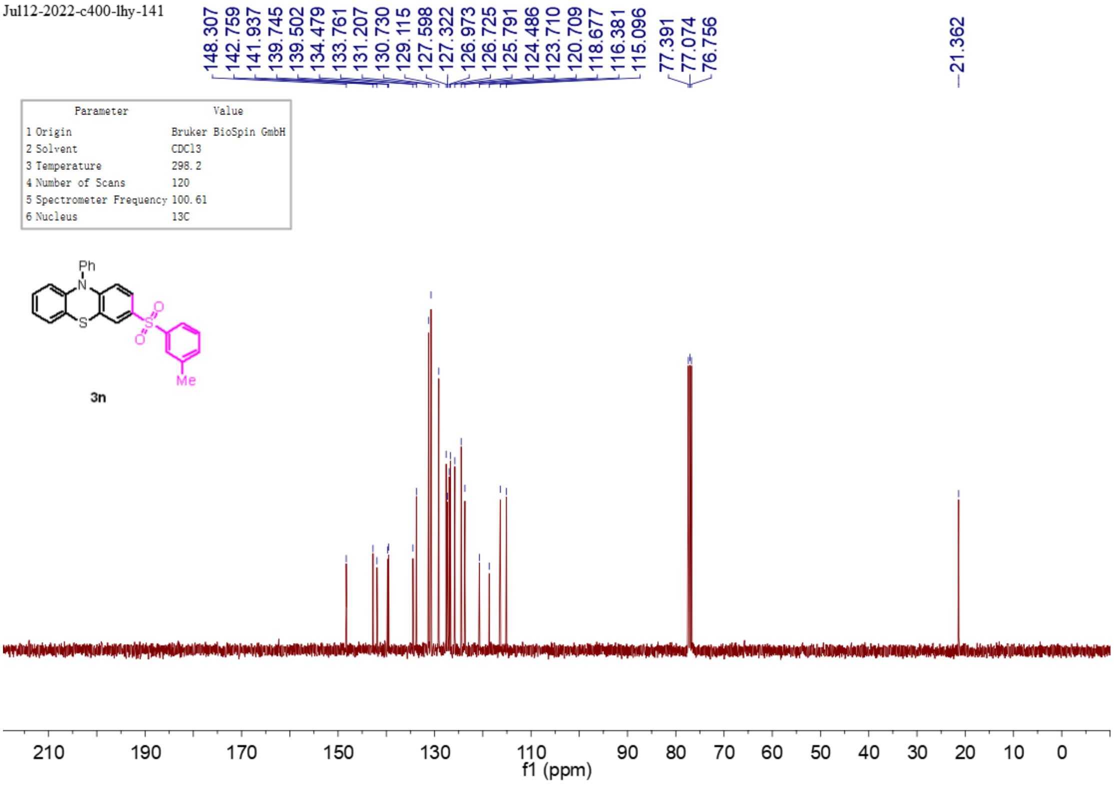


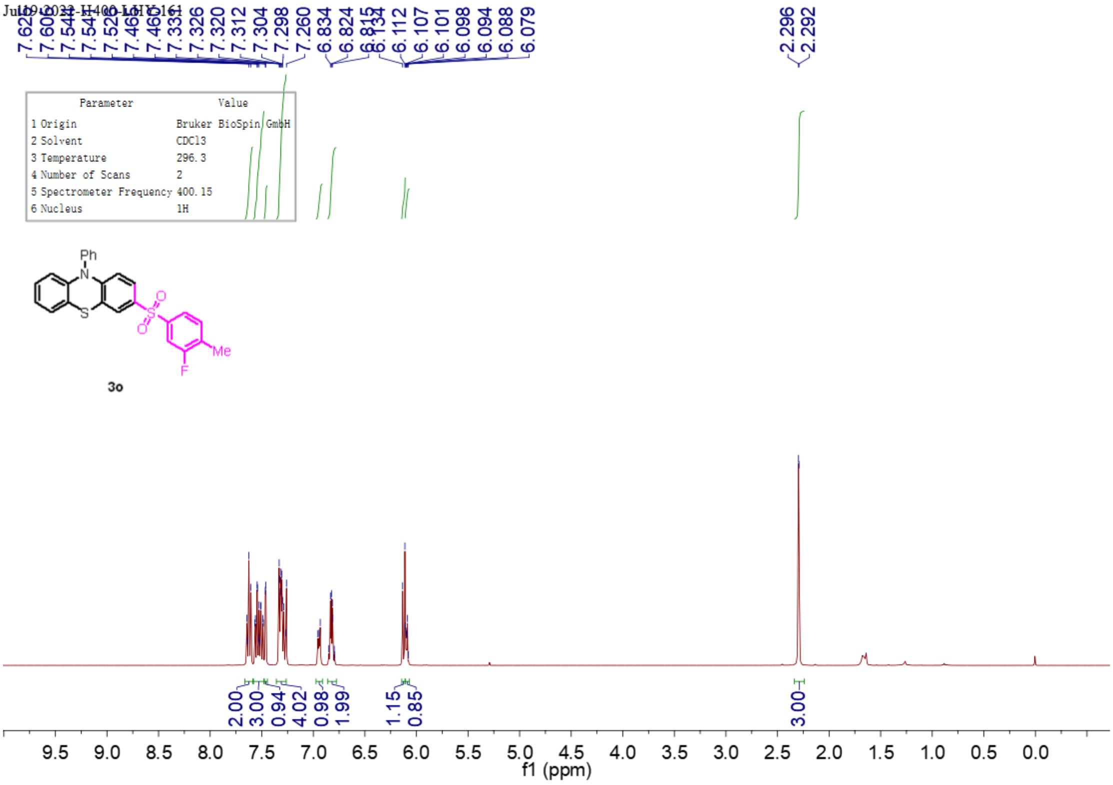

Jul08-2022-H400-LHY-137
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 296.9
4 Number of Scans 80
5 Spectrometer Frequency 100.62
6 Nucleus 13C
Ph
N
S
O
CN
3l
f1 (ppm)


Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 2
5 Spectrometer Frequency 400.13
6 Nucleus 1H
Ph
N
S
O
O2N
3m
f1 (ppm)

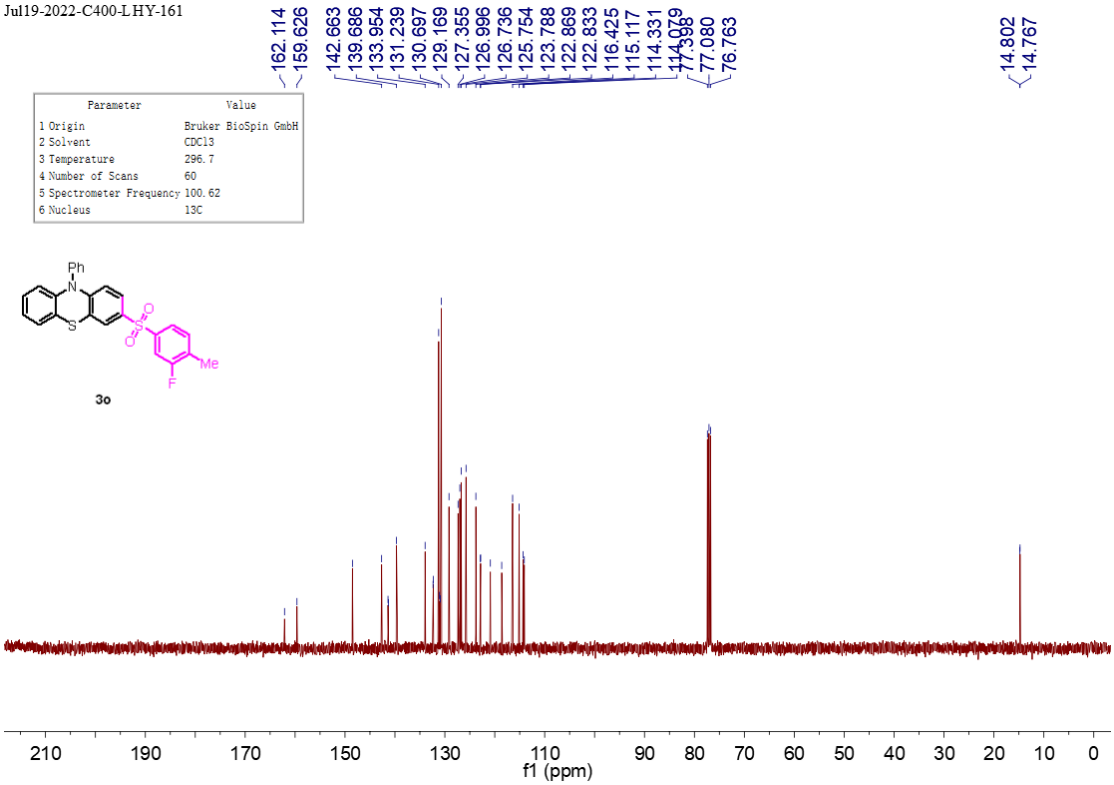

Jul21-2022-c400-lhy-160
148.927
148.317
142.548
139.594
135.095
134.204
132.674
132.390
131.268
130.669
129.212
128.151
127.351
126.739
126.477
124.562
123.875
120.528
118.650
116.494
114.742
77.369
77.052
76.734
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 1024
5 Spectrometer Frequency 100.61
6 Nucleus 13C
Ph
N
S
O
S
O
O2N
3m
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


7.352
7.346
7.332
7.318
7.312
7.260
6.936
6.832
6.821
6.137
6.115
6.111
6.106
6.099
6.094
6.087
2.383
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.1
4 Number of Scans 2
5 Spectrometer Frequency 400.13
6 Nucleus 1H
Ph
N
S
O
S
O
Me
3n
1.96
2.04
2.04
5.04
1.00
2.04
2.01
3.00
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)

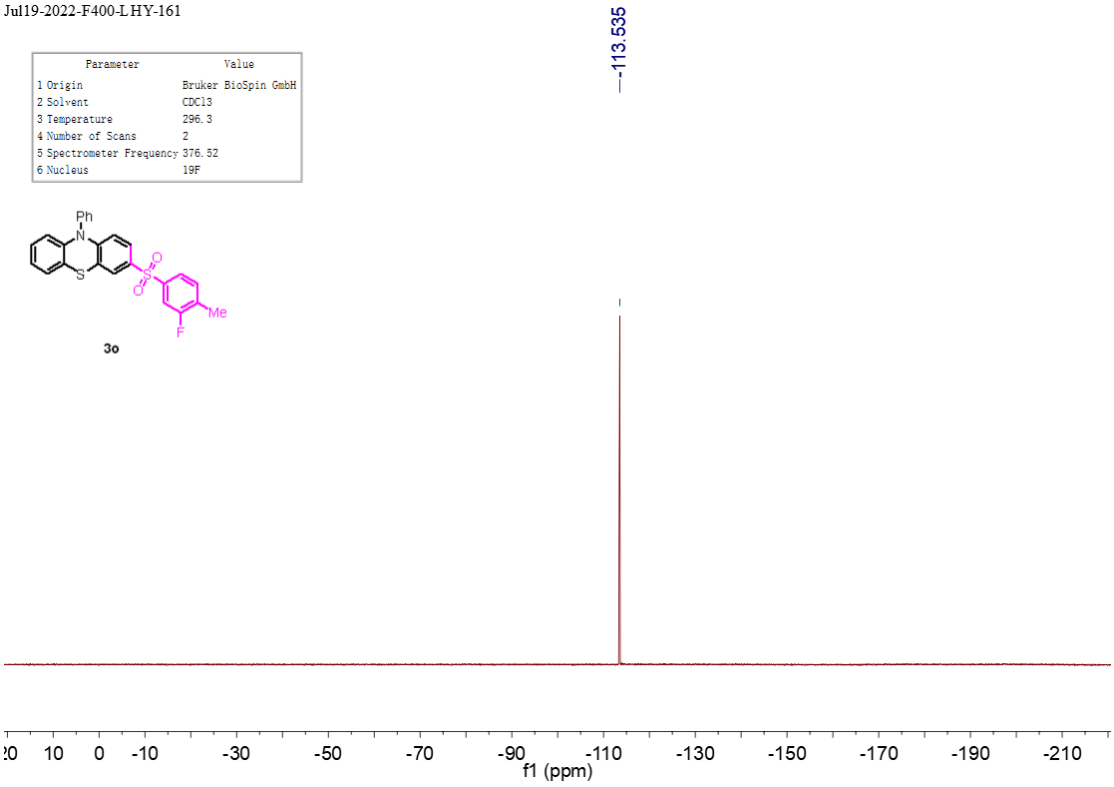

Jul12-2022-c400-lhy-141
148.307
142.759
141.937
139.745
139.502
134.479
133.761
131.207
130.730
129.115
127.598
127.322
126.973
126.725
125.791
124.486
123.710
120.709
118.677
116.381
115.096
77.391
77.074
76.756
21.362
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 120
5 Spectrometer Frequency 100.61
6 Nucleus 13C
Ph
N
S
O
S
O
Me
3n
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

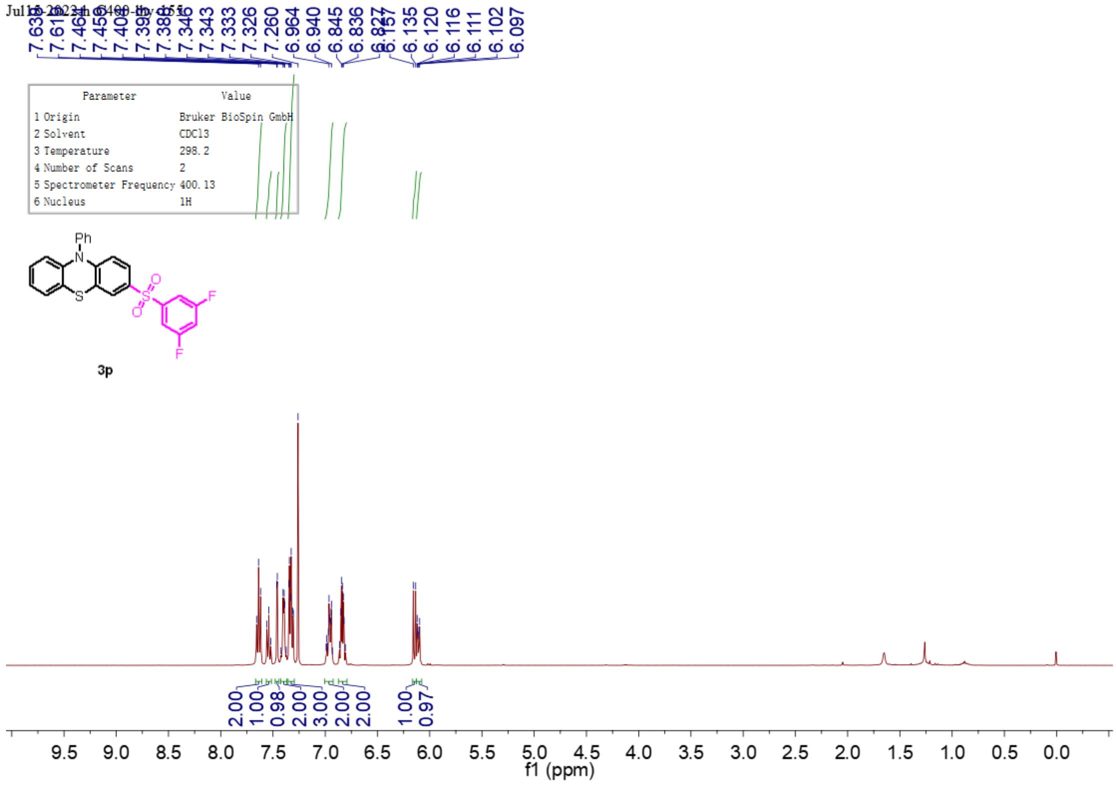

7.326
7.320
7.312
7.304
7.298
7.260
6.834
6.824
6.112
6.107
6.101
6.098
6.094
6.088
6.079
2.296
2.292
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 296.3
4 Number of Scans 2
5 Spectrometer Frequency 400.15
6 Nucleus 1H
Ph
N
S
O
S
O
Me
F
3o
2.00
3.00
0.94
4.02
0.98
1.99
1.15
0.85
3.00
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)

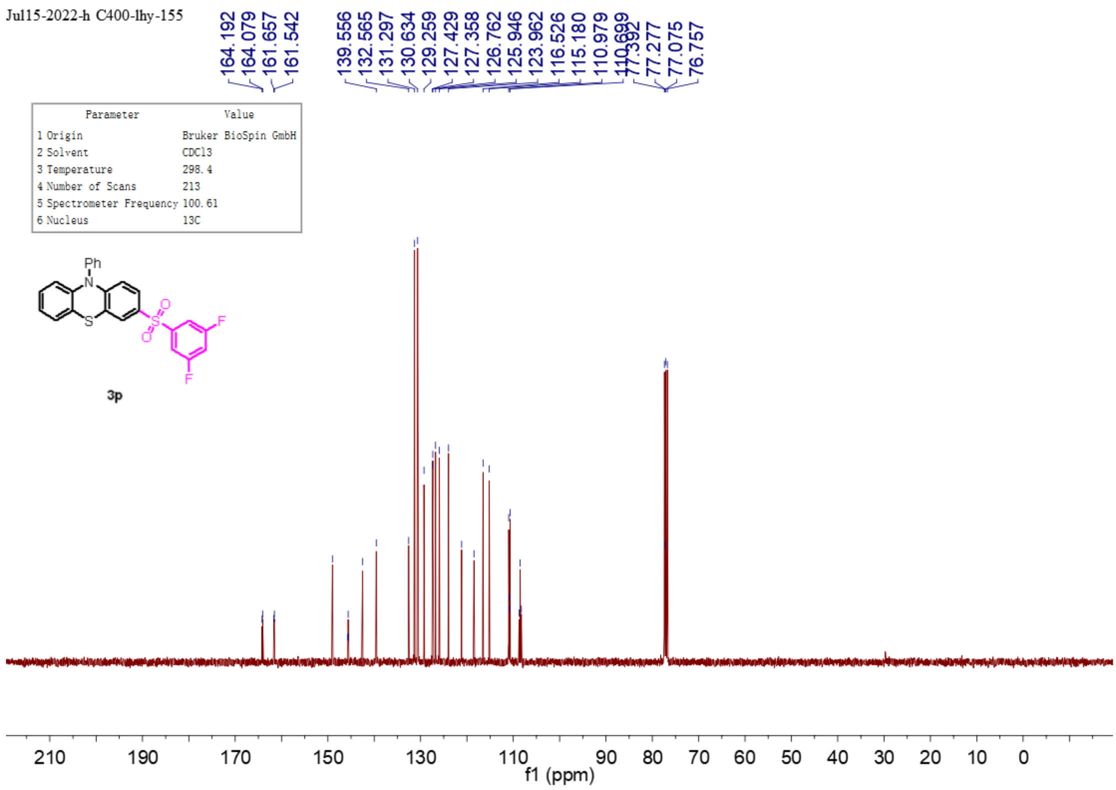
Jul19-2022-C400-LHY-161



Jul19-2022-F400-LHY-161

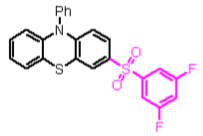



7.61
7.460
7.456
7.403
7.399
7.388
7.346
7.343
7.333
7.326
7.260
6.964
6.940
6.845
6.836
6.827
6.157
6.135
6.120
6.116
6.111
6.102
6.097
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 2
5 Spectrometer Frequency 400.13
6 Nucleus 1H
Ph
N
S
O
O
S
F
F
3p
2.00
1.00
0.98
2.00
3.00
2.00
2.00
1.00
0.97
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)


Jul15-2022-h C400-lhy-155
164.192
164.079
161.657
161.542
139.556
132.565
131.297
130.634
129.259
127.429
127.358
126.762
125.946
123.962
116.526
115.180
110.979
110.699
77.392
77.277
77.075
76.757
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.4
4 Number of Scans 213
5 Spectrometer Frequency 100.61
6 Nucleus 13C
Ph
N
S
O
O
S
F
F
3p
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

Jul18-2022-F400-LHY-155

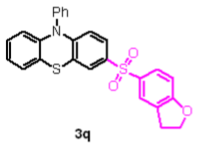
Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	297.5
4 Number of Scans	2
5 Spectrometer Frequency	376.52
6 Nucleus	19F



3p

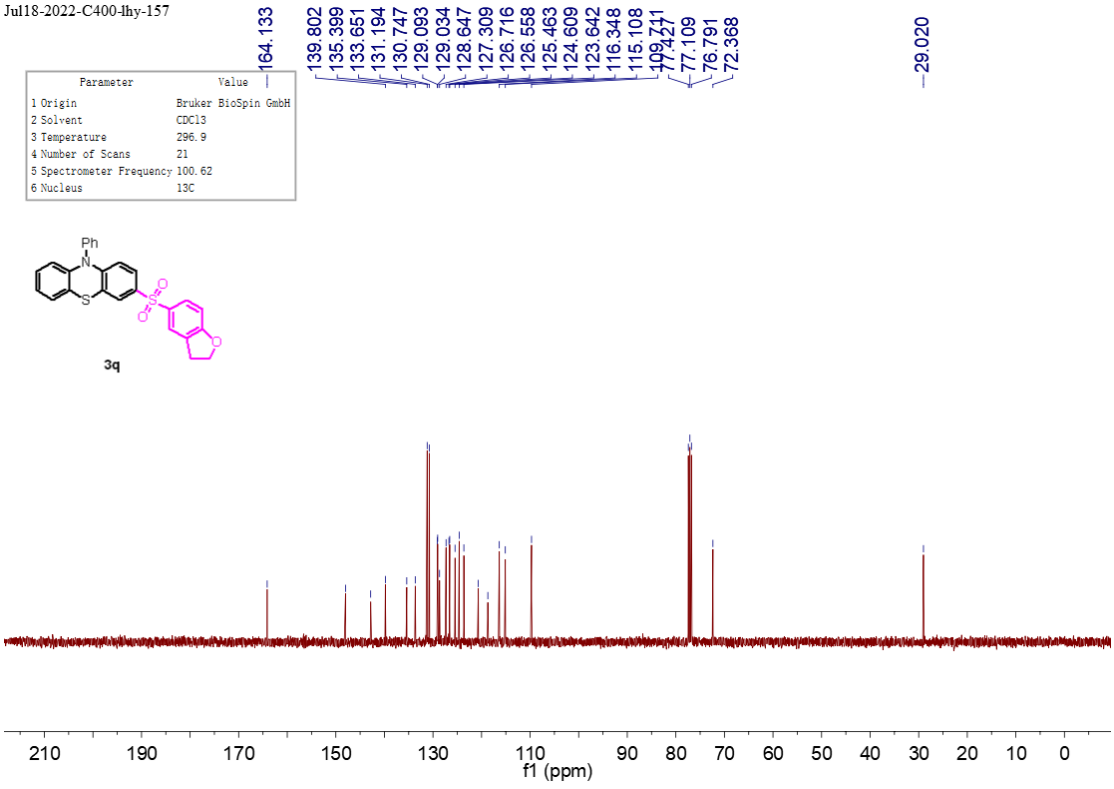
Jul18-2022-h400dch-155

Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	298.1
4 Number of Scans	2
5 Spectrometer Frequency	400.13
6 Nucleus	1H

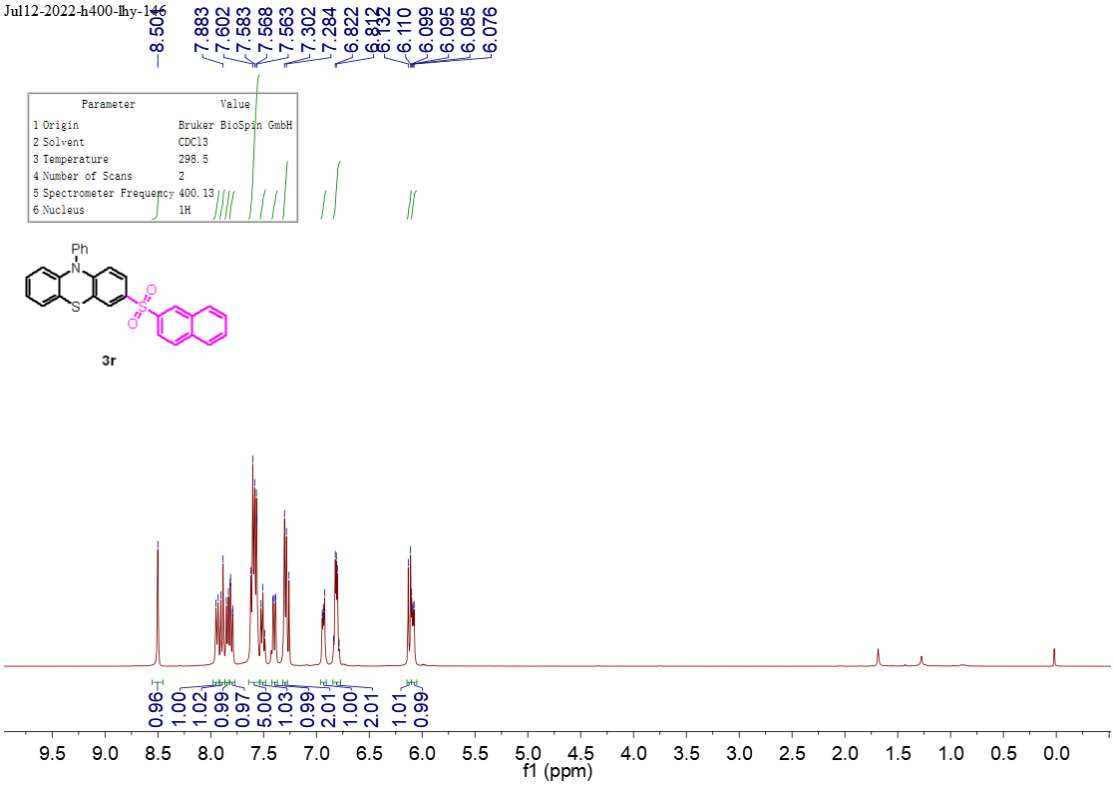


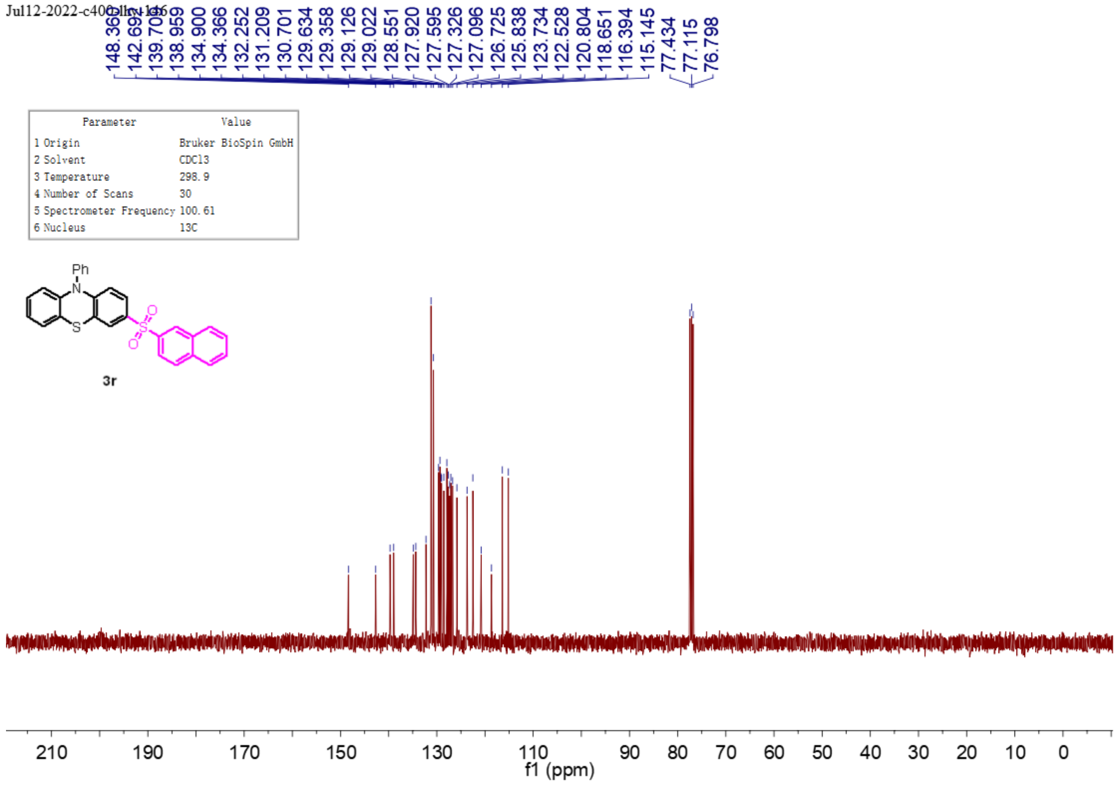
3q

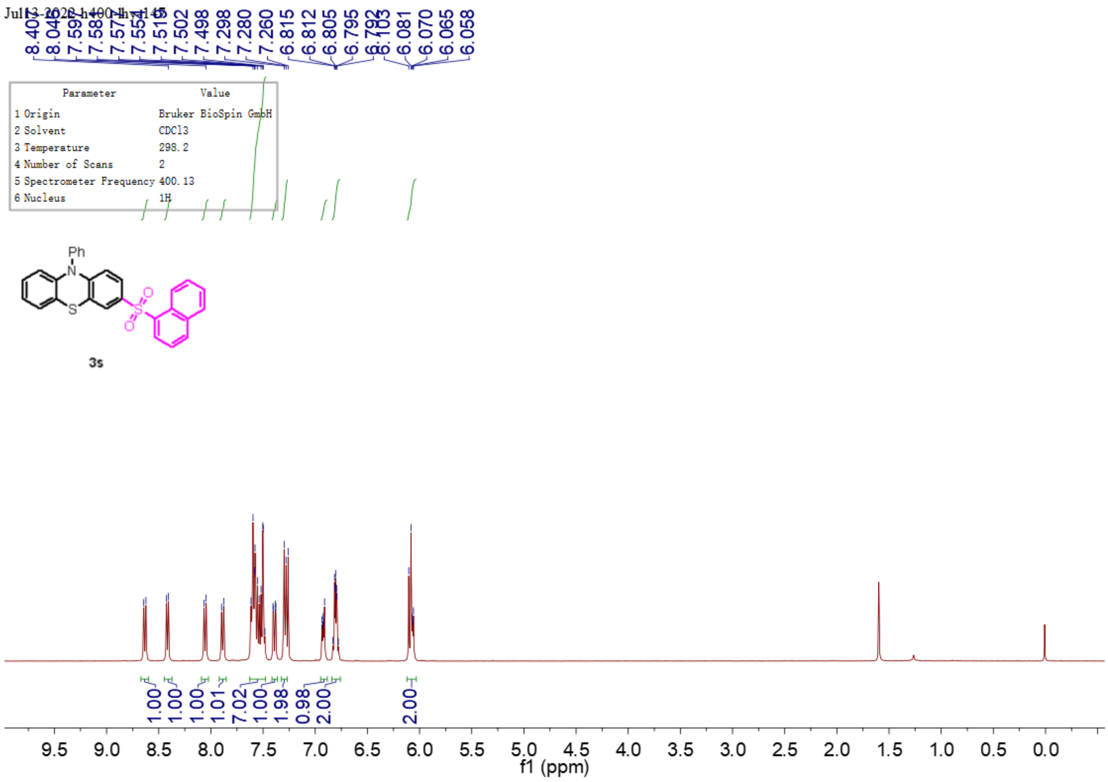
Jul18-2022-C400-lhy-157

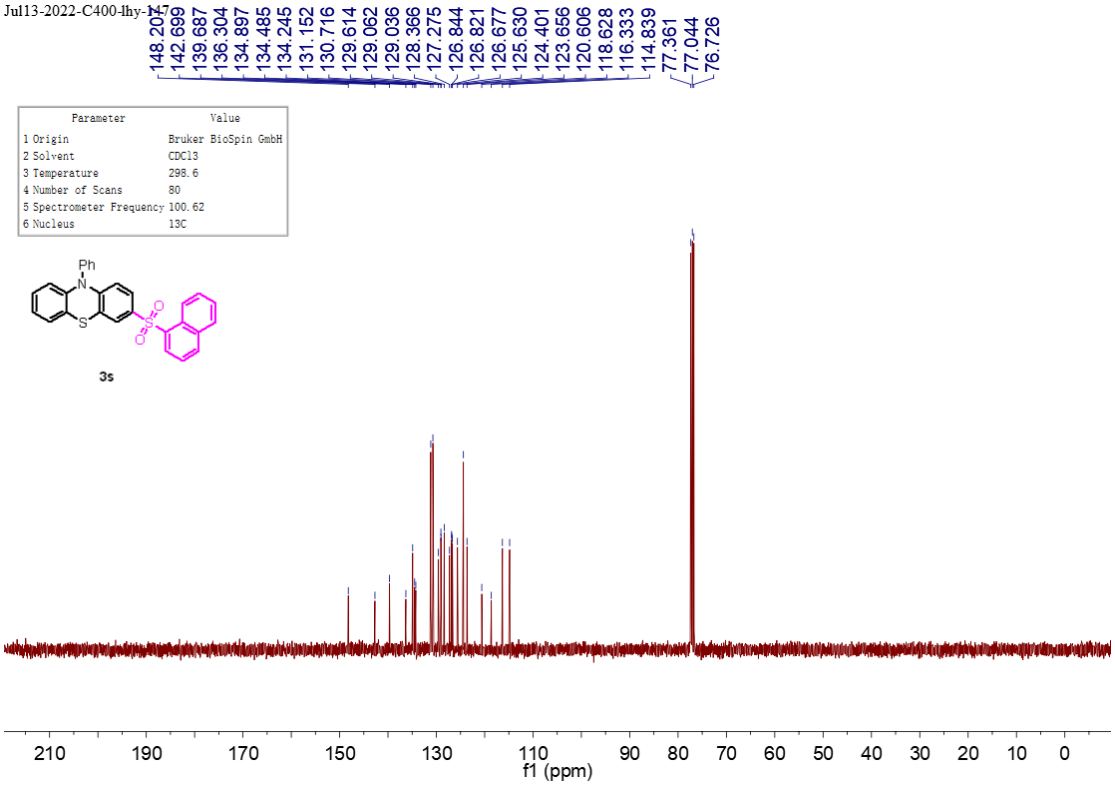


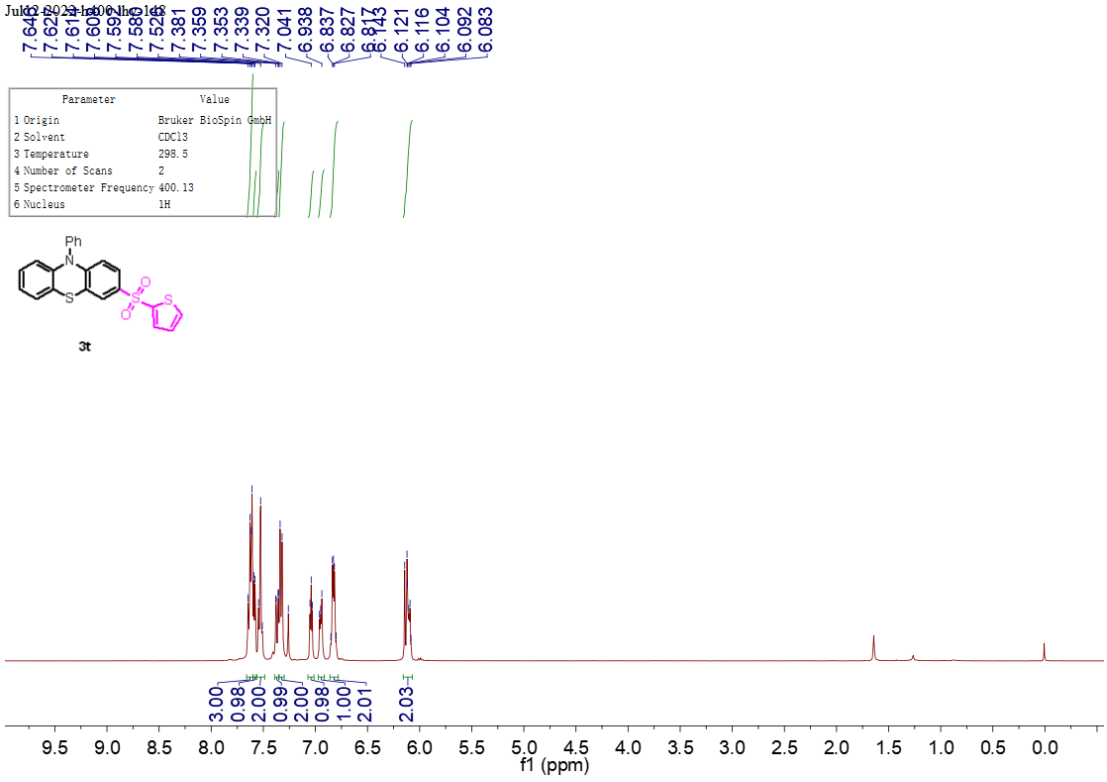
Jul12-2022-h400-lhy-146




Jul12-2022-c400-lhw-146
142.693
139.708
138.959
134.900
134.366
132.252
131.209
130.701
129.634
129.358
129.126
129.022
128.551
127.920
127.595
127.326
127.096
126.725
125.838
123.734
122.528
120.804
118.651
116.394
115.145
77.434
77.115
76.798
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.9
4 Number of Scans 30
5 Spectrometer Frequency 100.61
6 Nucleus 13C
Ph
N
S
O
O
3r
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


7.515
7.502
7.498
7.298
7.280
7.260
6.815
6.812
6.805
6.795
6.081
6.070
6.065
6.058
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 2
5 Spectrometer Frequency 400.13
6 Nucleus 1H
Ph
N
S
O
O
3s
1.00
1.00
1.00
1.01
7.02
1.00
1.98
0.98
2.00
2.00
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)

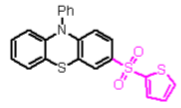

Jul13-2022-C400-lhy-147
148.207
142.699
139.687
136.304
134.897
134.485
134.245
131.152
130.716
129.614
129.062
129.036
128.366
127.275
126.844
126.821
126.677
125.630
124.401
123.656
120.606
118.628
116.333
114.839
77.361
77.044
76.726
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.6
4 Number of Scans 80
5 Spectrometer Frequency 100.62
6 Nucleus 13C
Ph
N
S
O
O
3s
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


Jul13-2022-400-lhy-143
7.646
7.625
7.614
7.606
7.592
7.586
7.526
7.381
7.359
7.353
7.339
7.320
7.041
6.938
6.837
6.827
6.817
6.143
6.121
6.116
6.104
6.092
6.083
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.5
4 Number of Scans 2
5 Spectrometer Frequency 400.13
6 Nucleus 1H
Ph
N
S
O
O
S
3t
3.00
0.98
2.00
0.99
2.00
0.98
1.00
2.01
2.03
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)

Jul12-2022-c400-lhy-148

148.453
143.742
142.684
139.702
134.742
133.339
132.747
131.241
130.712
129.163
127.782
127.352
126.733
126.717
125.502
123.778
120.766
118.638
116.430
115.084
77.406
77.089
76.771

Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	299.0
4 Number of Scans	34
5 Spectrometer Frequency	100.61
6 Nucleus	13C



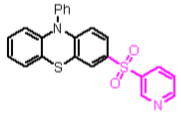
3t

210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

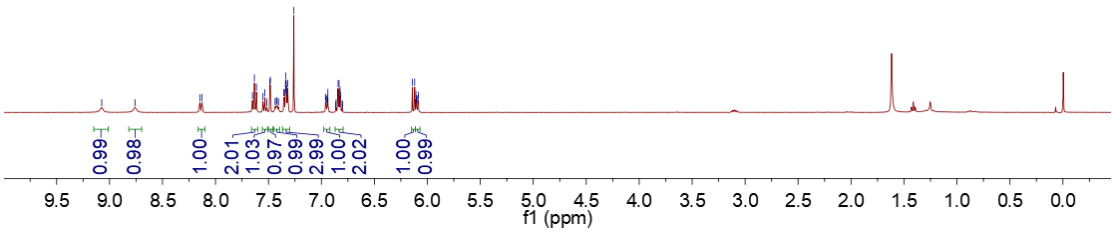
Jul15-2022-h400-lhy-149

9.078
8.766
8.148
8.128
7.633
7.487
7.482
7.336
7.333
7.318
7.260
6.122
6.120
6.108
6.104
6.100
6.090
6.085

Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	298.1
4 Number of Scans	2
5 Spectrometer Frequency	400.13
6 Nucleus	1H

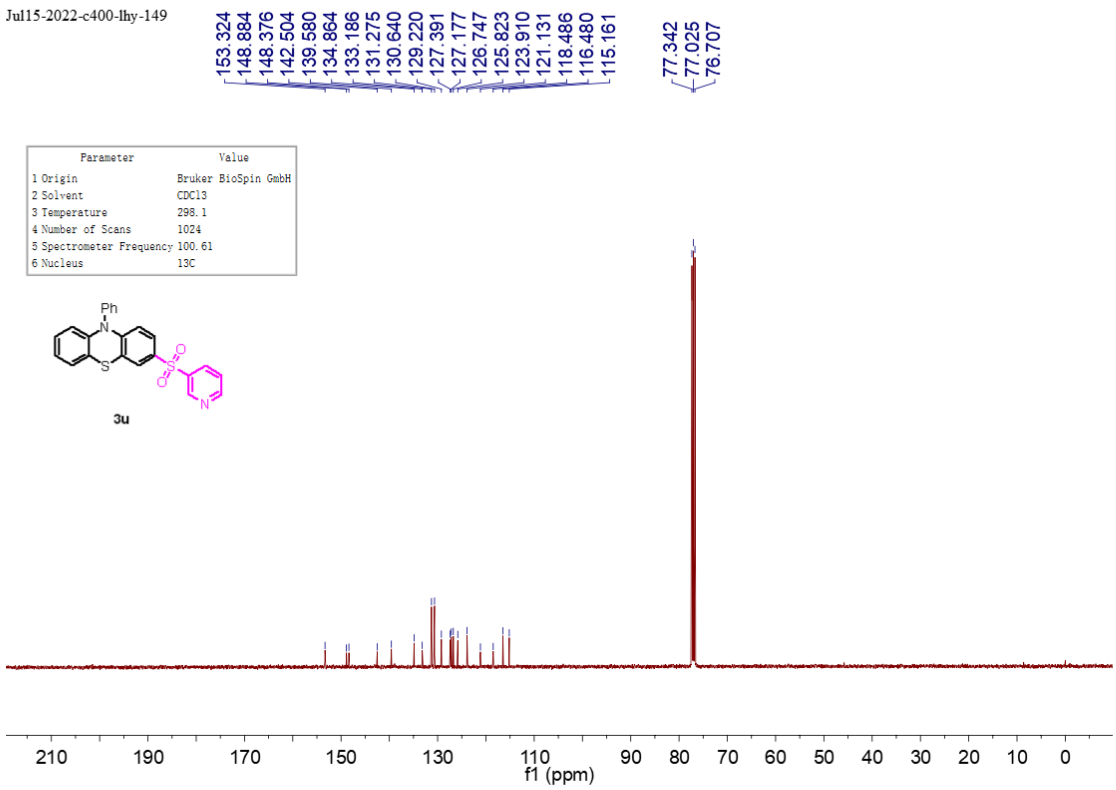


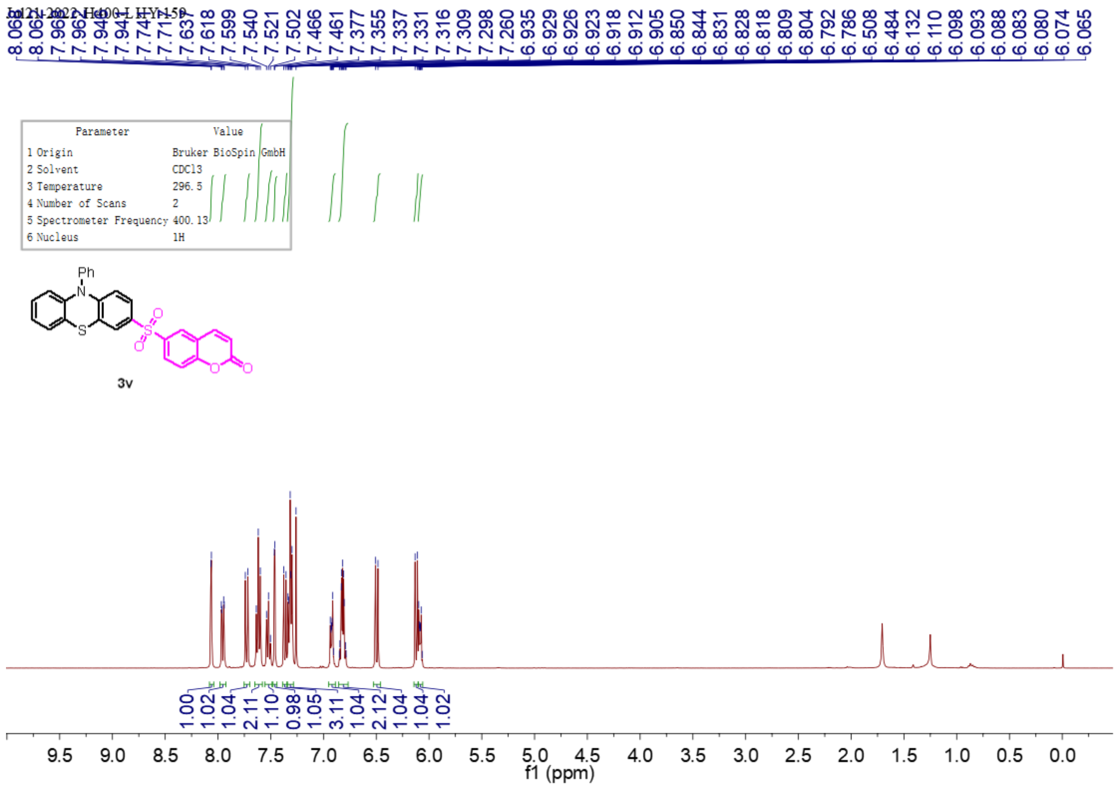
3u

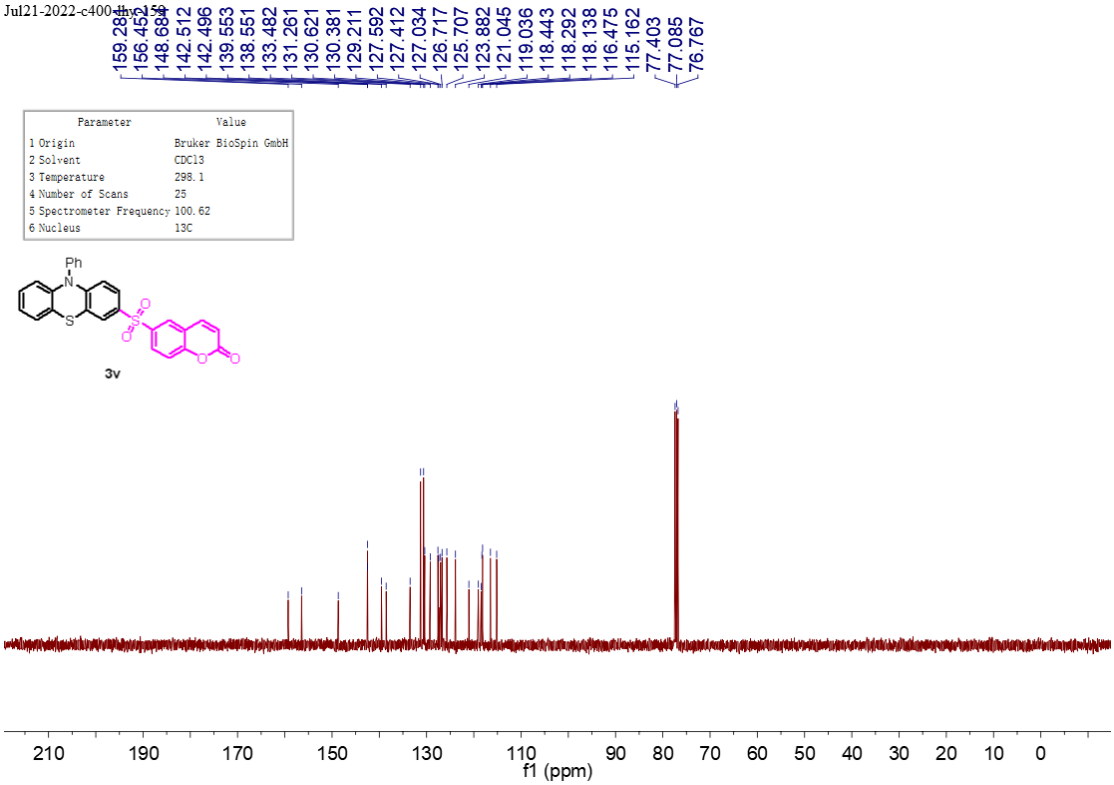


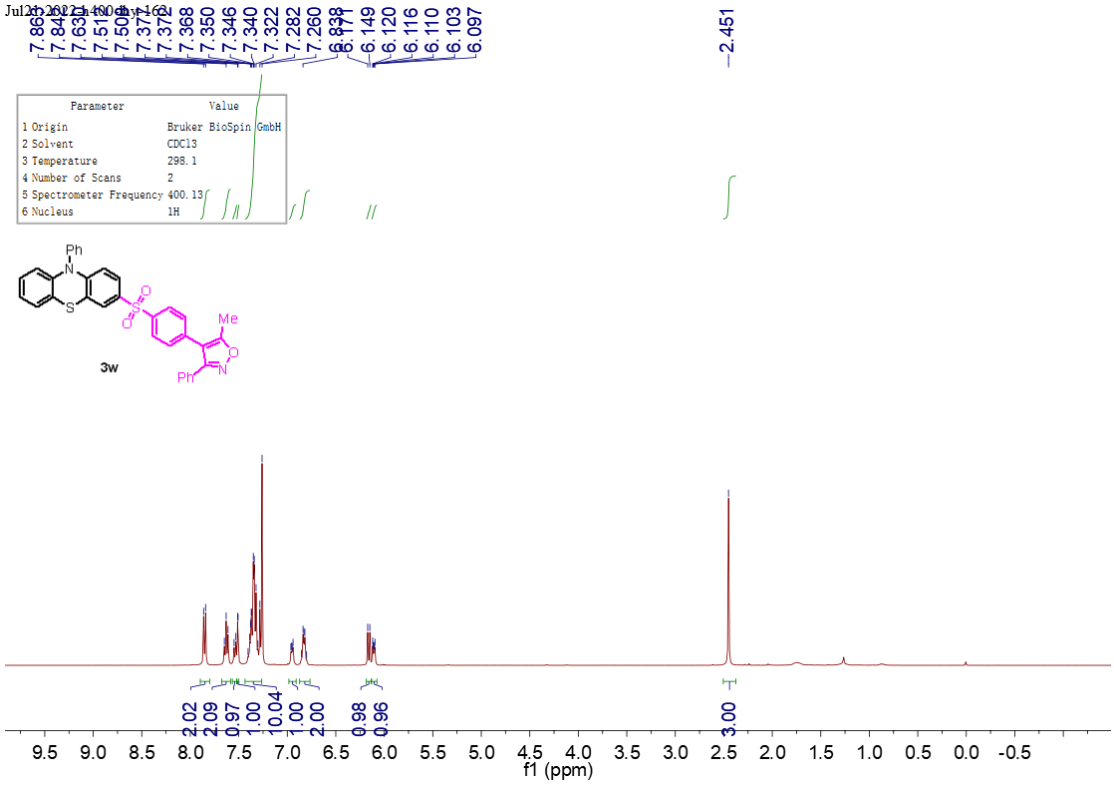
0.99 0.98 1.00 2.01 1.03 0.97 0.99 2.99 1.00 2.02 1.00 0.99

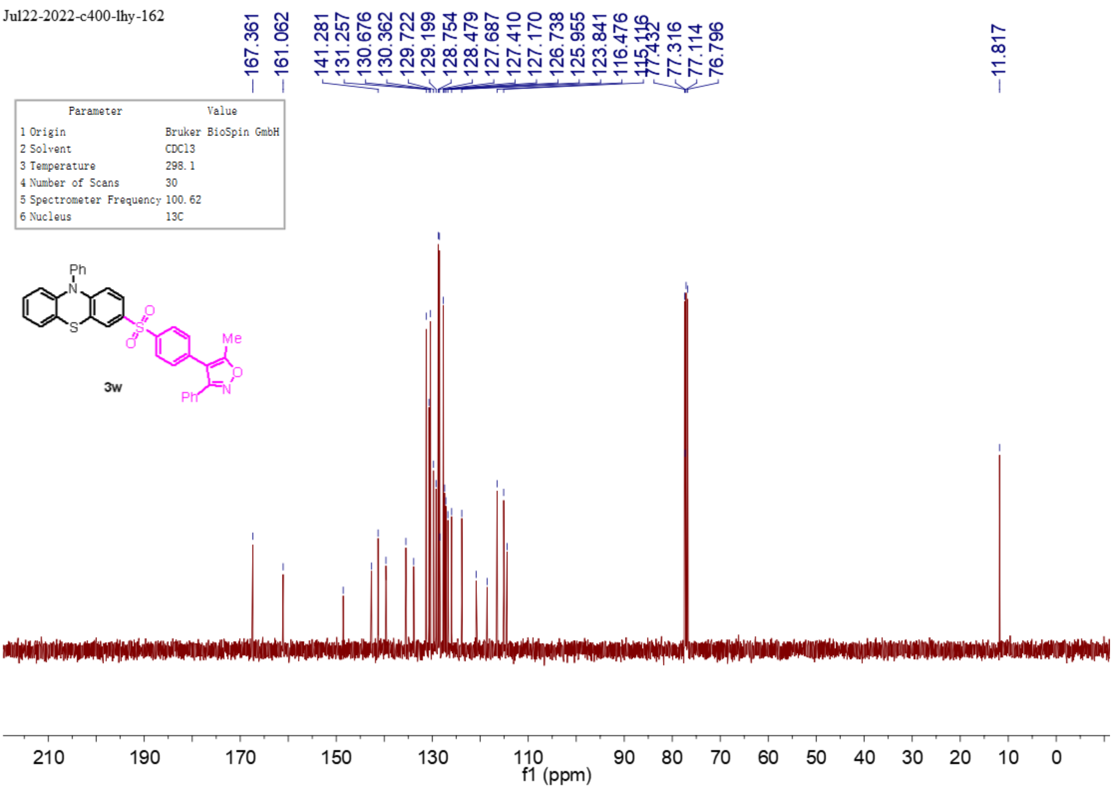
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

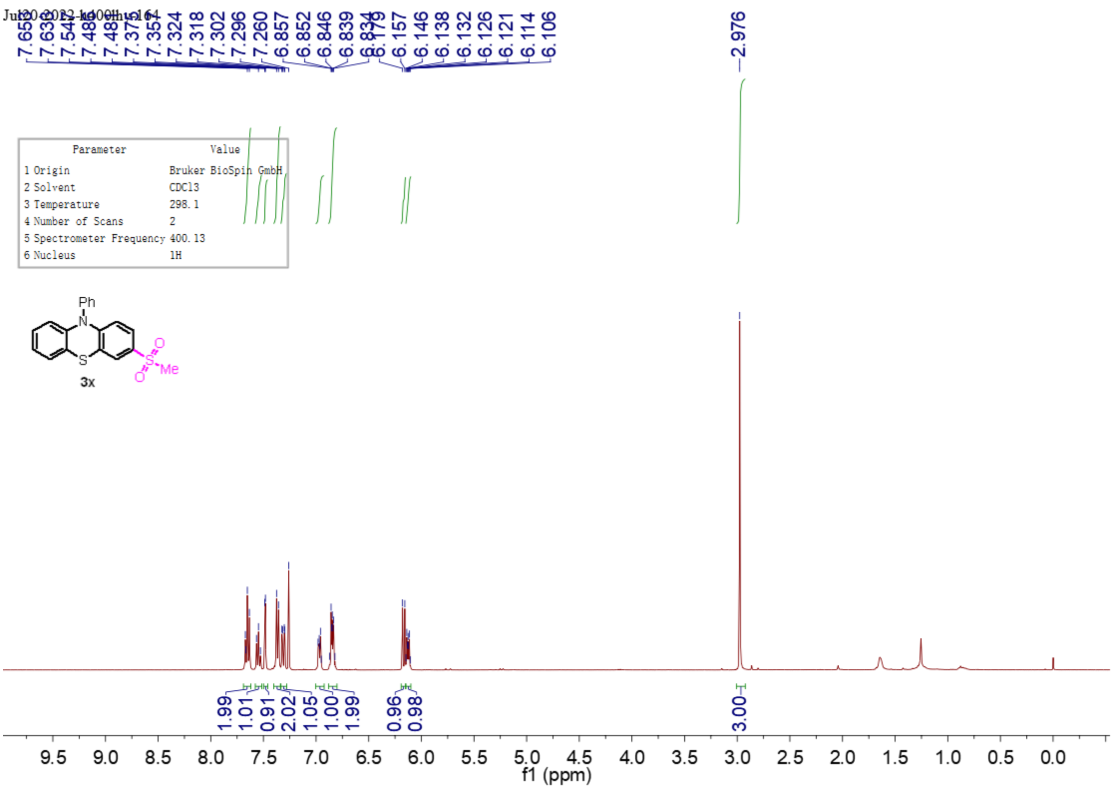

Jul15-2022-c400-lhy-149
153.324
148.884
148.376
142.504
139.580
134.864
133.186
131.275
130.640
129.220
127.391
127.177
126.747
125.823
123.910
121.131
118.486
116.480
115.161
77.342
77.025
76.707
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.1
4 Number of Scans 1024
5 Spectrometer Frequency 100.61
6 Nucleus 13C
Ph
N
S
O
O
N
3u
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

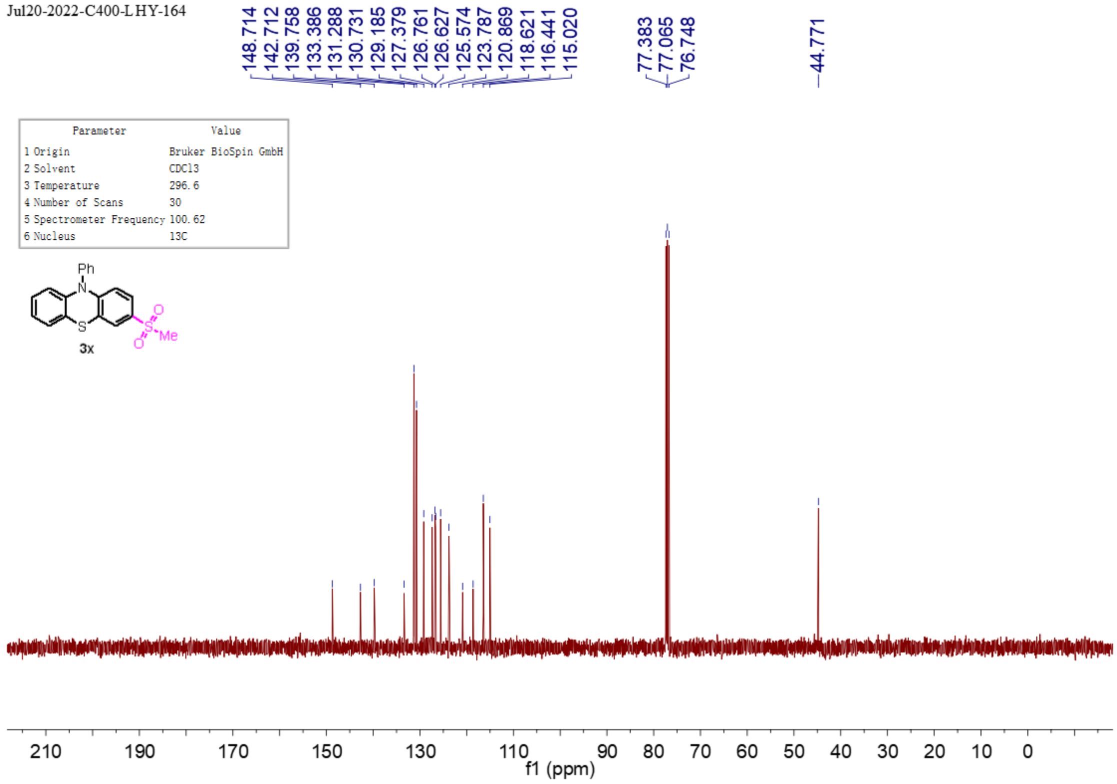

7.618
7.599
7.540
7.521
7.502
7.466
7.461
7.377
7.355
7.337
7.331
7.316
7.309
7.298
7.260
6.935
6.929
6.926
6.923
6.918
6.912
6.905
6.850
6.844
6.831
6.828
6.818
6.809
6.804
6.792
6.786
6.508
6.484
6.132
6.110
6.098
6.093
6.088
6.083
6.080
6.074
6.065
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 296.5
4 Number of Scans 2
5 Spectrometer Frequency 400.13
6 Nucleus 1H
Ph
N
S
O
O
O
O
3v
1.00
1.02
1.04
2.11
1.10
0.98
1.05
3.11
1.04
2.12
1.04
1.04
1.02
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)

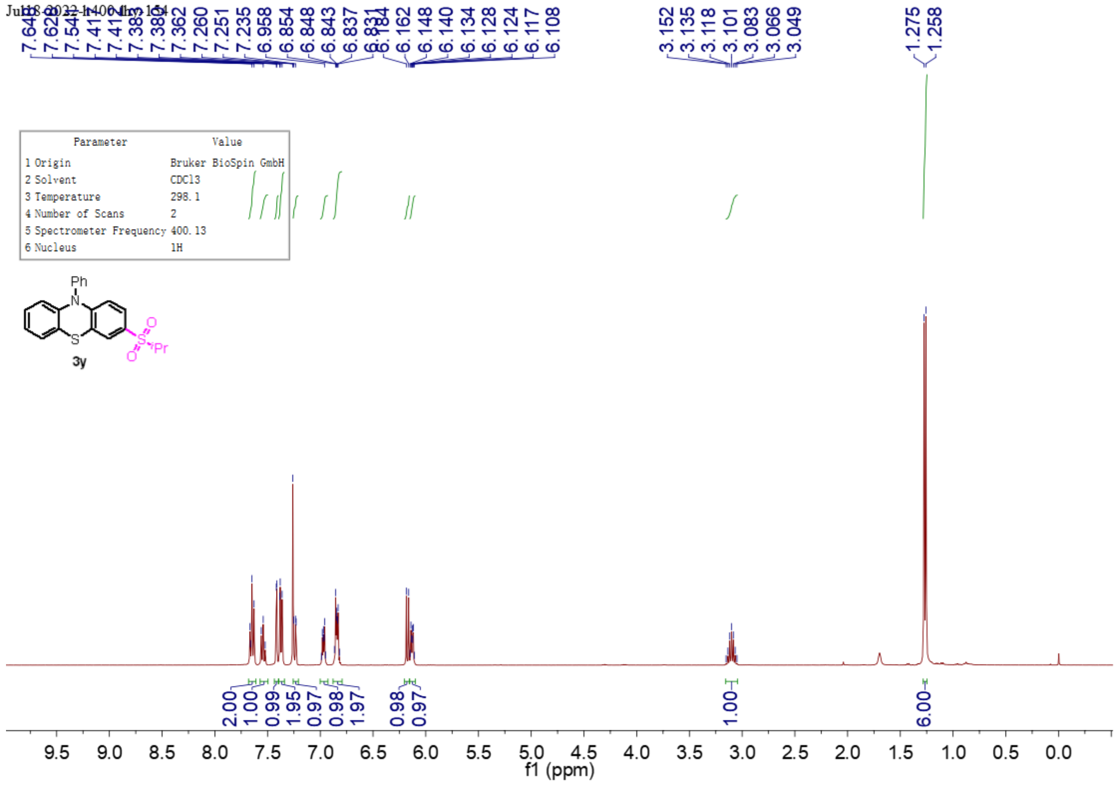

Jul21-2022-c400-dhy-159
159.285
156.455
148.684
142.512
142.496
139.553
138.551
133.482
131.261
130.621
130.381
129.211
127.592
127.412
127.034
126.717
125.707
123.882
121.045
119.036
118.443
118.292
118.138
116.475
115.162
77.403
77.085
76.767
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.1
4 Number of Scans 25
5 Spectrometer Frequency 100.62
6 Nucleus 13C
Ph
N
S
O
O
O
O
3v
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

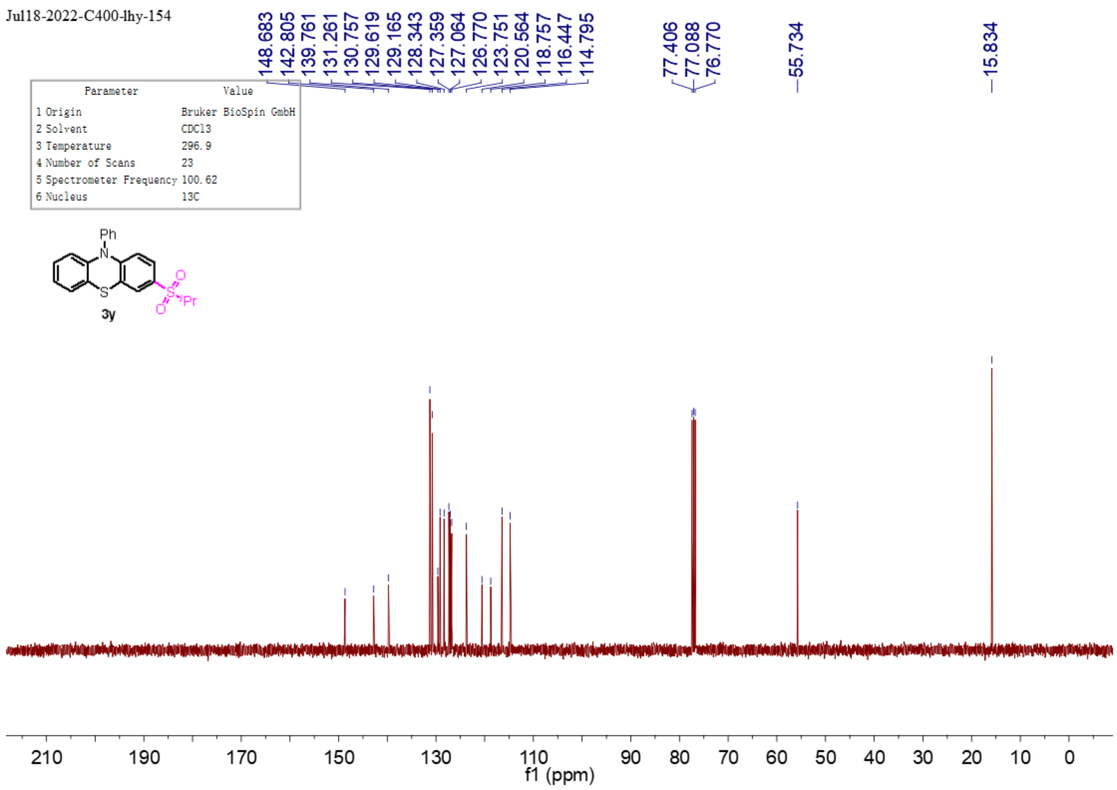

Jul21-2022-c400-dhy-162
7.865
7.844
7.631
7.513
7.504
7.375
7.372
7.368
7.350
7.346
7.340
7.322
7.282
7.260
6.838
6.171
6.149
6.120
6.116
6.110
6.103
6.097
2.451
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.1
4 Number of Scans 2
5 Spectrometer Frequency 400.13
6 Nucleus 1H
Ph
N
S
O
O
O
Me
Ph
3w
2.02
2.09
0.97
1.00
10.04
1.00
2.00
0.98
0.96
3.00
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)

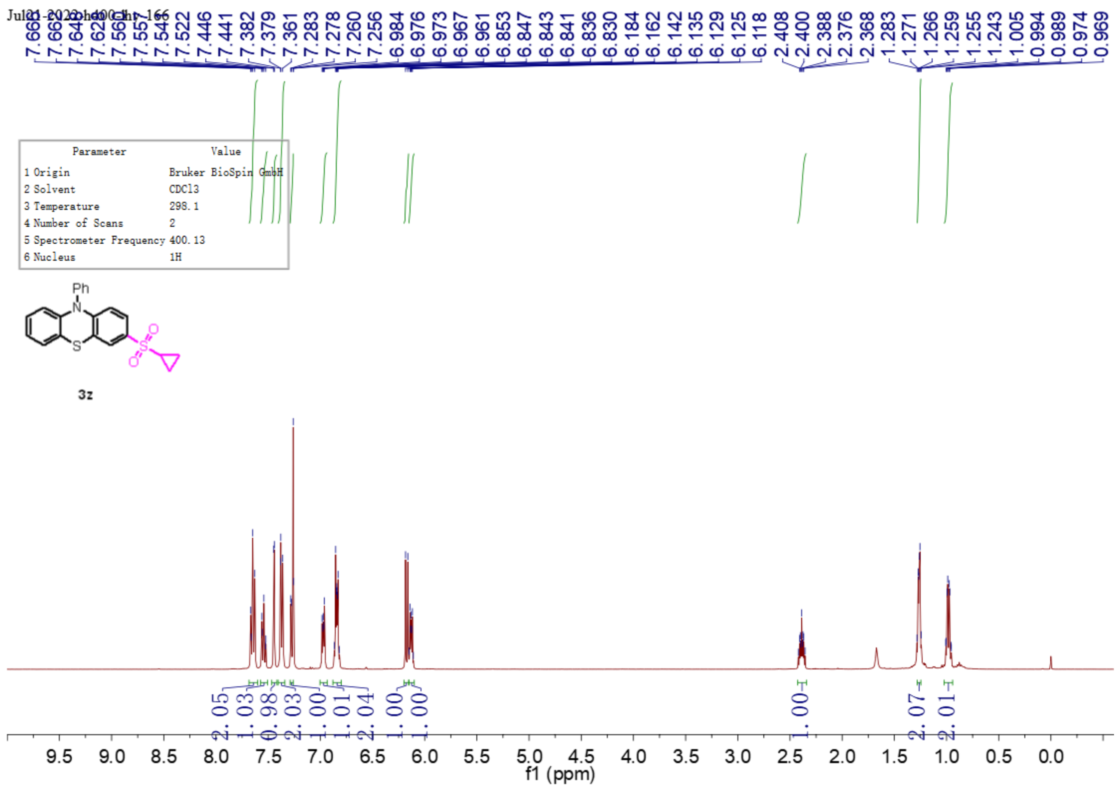

Jul22-2022-c400-lhy-162
167.361
161.062
141.281
131.257
130.676
130.362
129.722
129.199
128.754
128.479
127.687
127.410
127.170
126.738
125.955
123.841
116.476
77.316
77.114
76.796
11.817
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.1
4 Number of Scans 30
5 Spectrometer Frequency 100.62
6 Nucleus 13C
Ph
N
S
O
S
O
Me
O
N
Ph
3w
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


7.655
7.544
7.353
7.324
7.318
7.302
7.296
7.260
6.857
6.852
6.846
6.839
6.157
6.146
6.138
6.132
6.126
6.121
6.114
6.106
2.976
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.1
4 Number of Scans 2
5 Spectrometer Frequency 400.13
6 Nucleus 1H
Ph
N
S
O
S
O
Me
3x
1.99
1.01
0.91
2.02
1.05
1.00
1.99
0.96
0.98
3.00
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)


Jul20-2022-C400-LHY-164
148.714
142.712
139.758
133.386
131.288
130.731
129.185
127.379
126.761
126.627
125.574
123.787
120.869
118.621
116.441
115.020
77.383
77.065
76.748
44.771
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 296.6
4 Number of Scans 30
5 Spectrometer Frequency 100.62
6 Nucleus 13C
Ph
N
S
O
Me
3x
f1 (ppm)

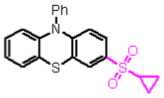

7.622
7.541
7.411
7.382
7.362
7.260
7.251
7.235
6.958
6.854
6.848
6.843
6.837
6.162
6.148
6.140
6.134
6.128
6.124
6.117
6.108
3.152
3.135
3.118
3.101
3.083
3.066
3.049
1.275
1.258
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.1
4 Number of Scans 2
5 Spectrometer Frequency 400.13
6 Nucleus 1H
Ph
N
S
O
iPr
3y
2.00
1.00
0.99
1.95
0.97
0.98
1.97
0.98
0.97
1.00
6.00
f1 (ppm)


Jul18-2022-C400-lhy-154
148.683
142.805
139.761
131.261
130.757
129.619
129.165
128.343
127.359
127.064
126.770
123.751
120.564
118.757
116.447
114.795
77.406
77.088
76.770
55.734
15.834
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 296.9
4 Number of Scans 23
5 Spectrometer Frequency 100.62
6 Nucleus 13C
Ph
N
S
O
O
S
iPr
3y
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

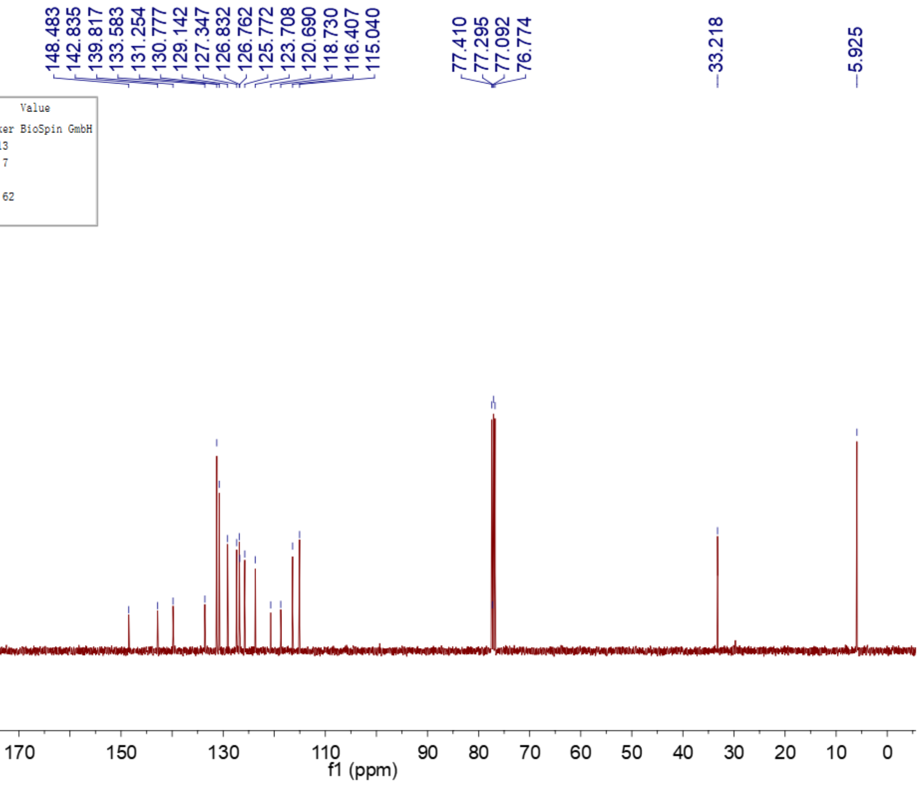

Jul21-2022-h400-lhy-166
7.661
7.663
7.640
7.622
7.560
7.551
7.544
7.522
7.446
7.441
7.382
7.379
7.361
7.283
7.278
7.260
7.256
6.984
6.976
6.973
6.967
6.961
6.853
6.847
6.843
6.841
6.836
6.830
6.184
6.162
6.142
6.135
6.129
6.125
6.118
2.408
2.400
2.388
2.376
2.368
1.283
1.271
1.266
1.259
1.255
1.243
1.005
0.994
0.989
0.974
0.969
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.1
4 Number of Scans 2
5 Spectrometer Frequency 400.13
6 Nucleus 1H
Ph
N
S
O
O
S
3z
2.05
1.03
0.98
2.03
1.00
1.01
2.04
1.00
1.00
1.00
2.07
2.01
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)

Jul22-2022-C400-LHY-166

Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	296.7
4 Number of Scans	40
5 Spectrometer Frequency	100.62
6 Nucleus	13C

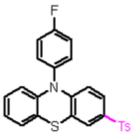


3z

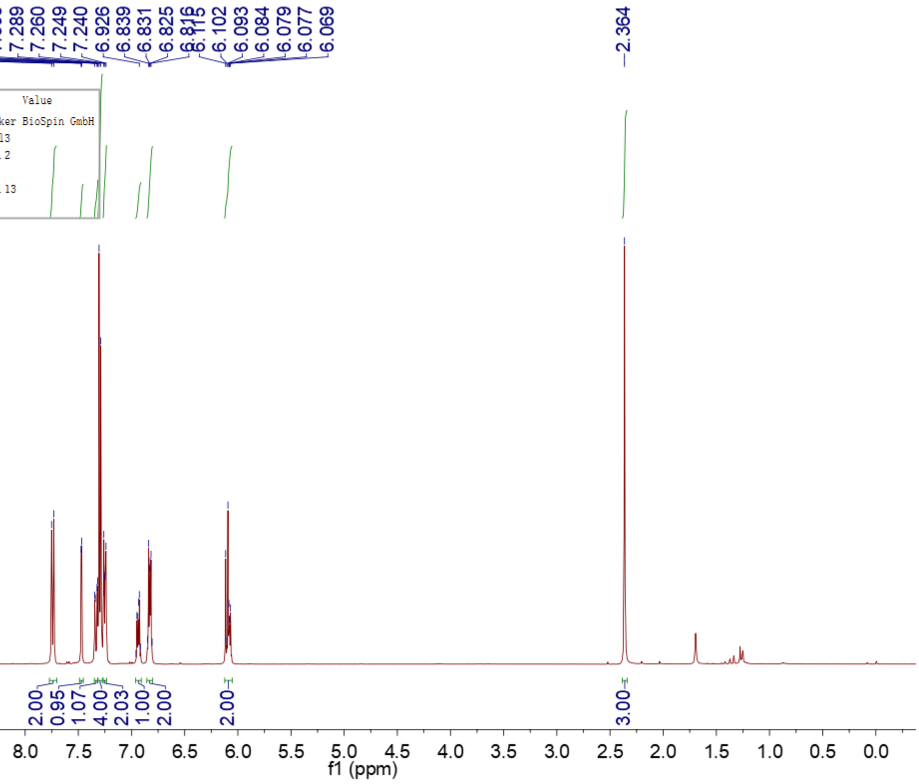


Aug19-2022-h400-lhy-205

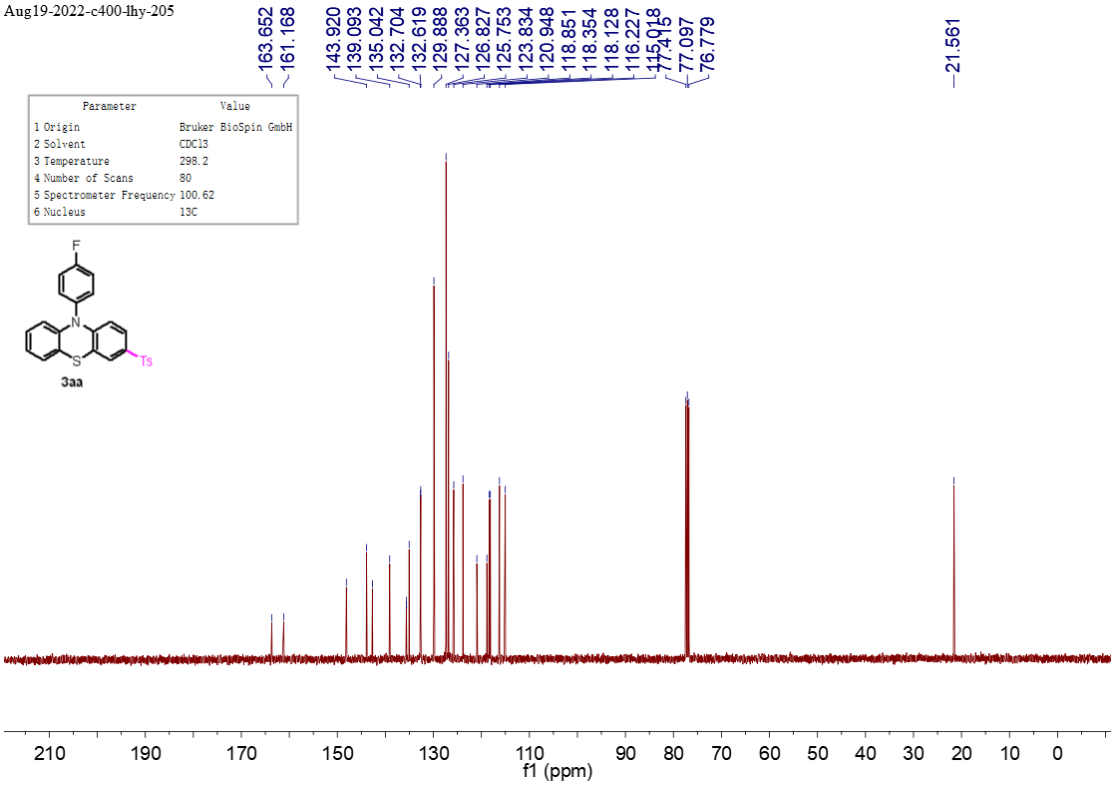
Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	298.2
4 Number of Scans	2
5 Spectrometer Frequency	400.13
6 Nucleus	1H



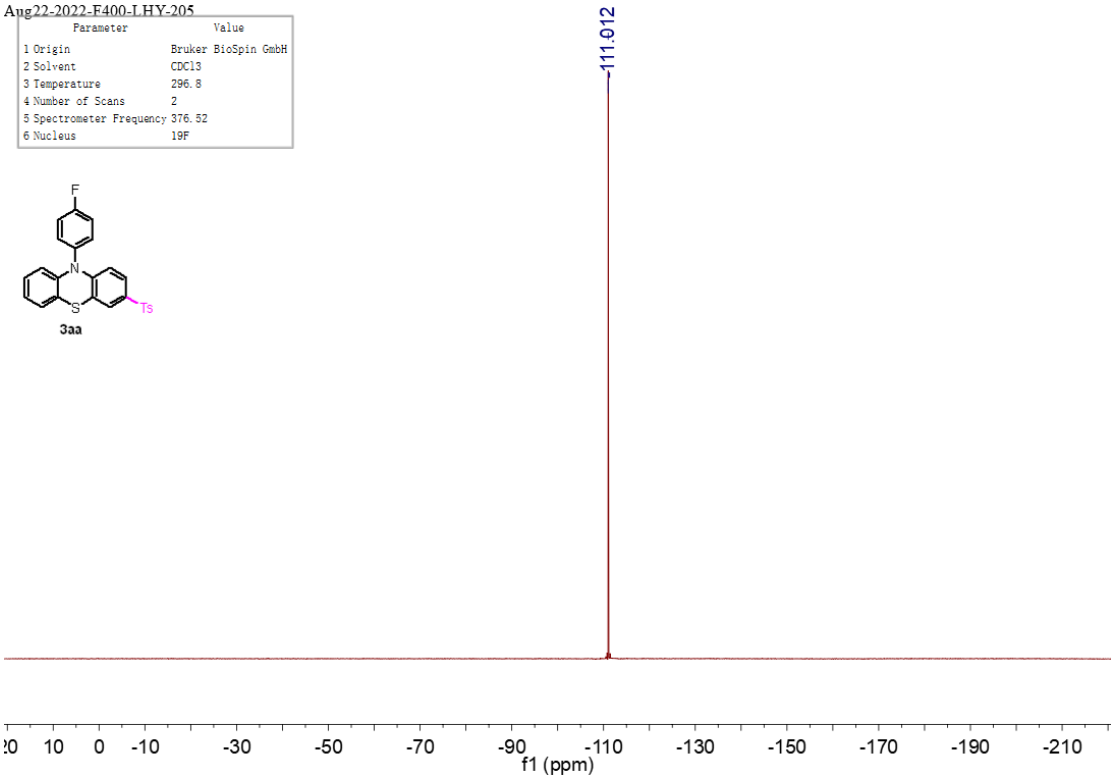
3aa

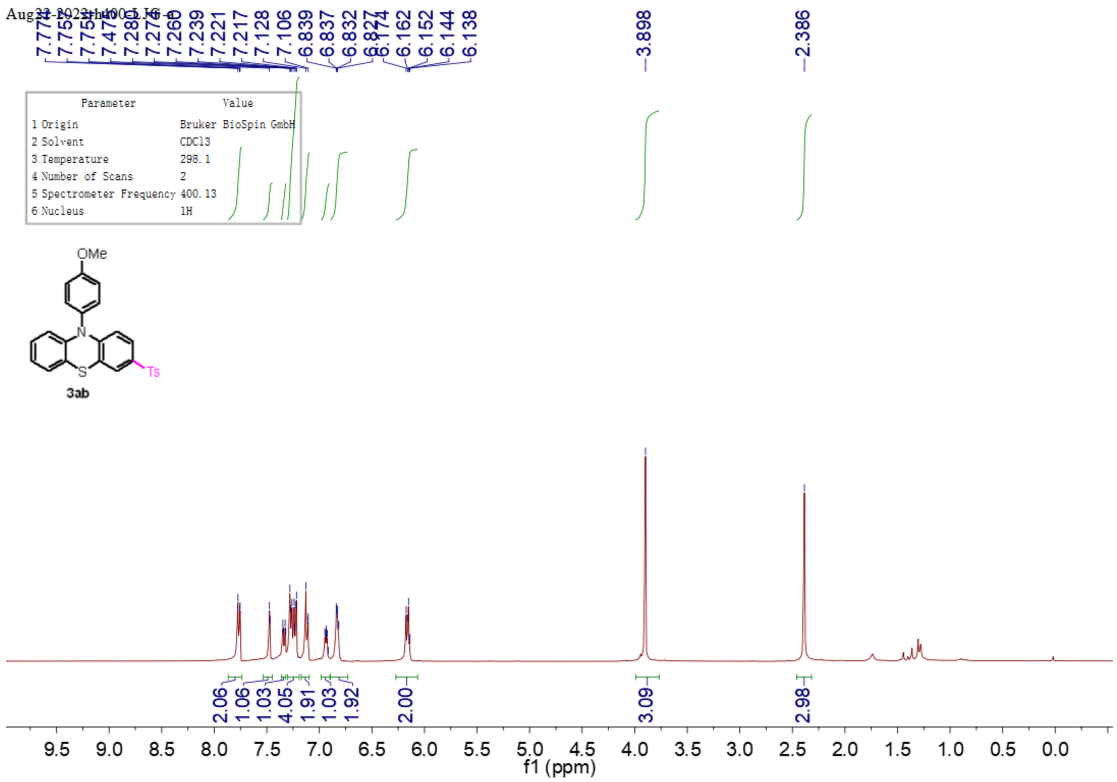


Aug19-2022-c400-lhy-205

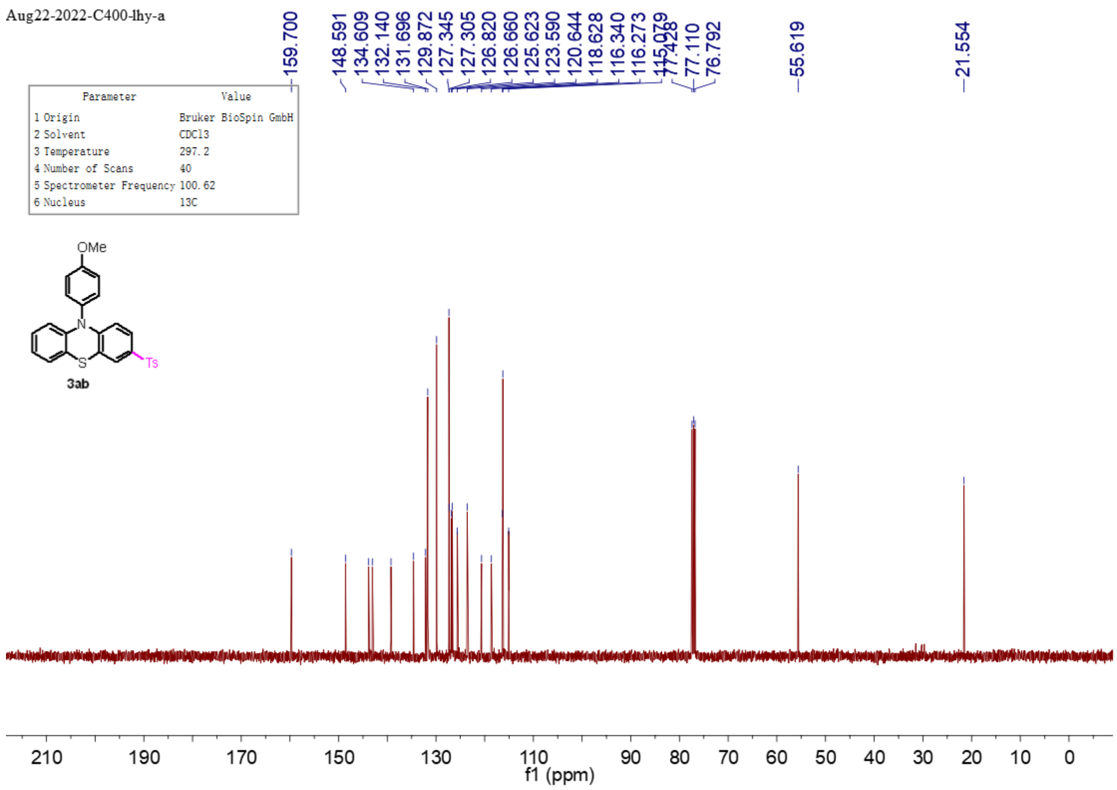


Aug22-2022-F400-LHY-205

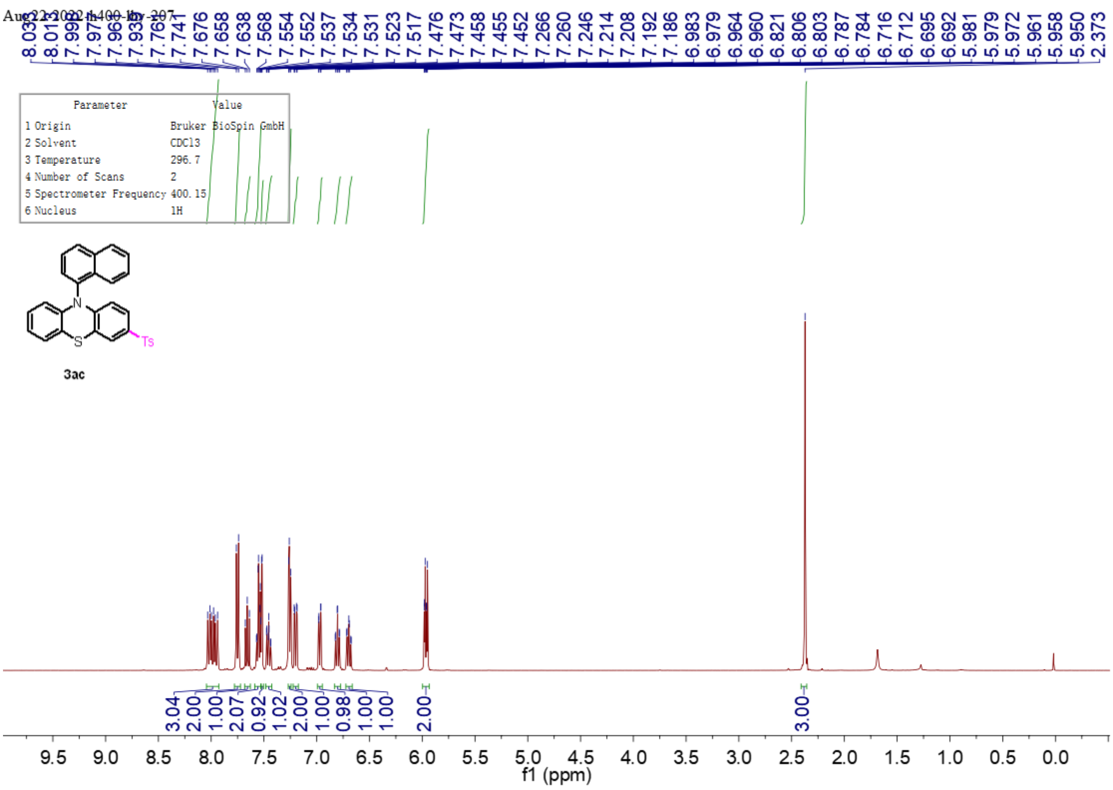


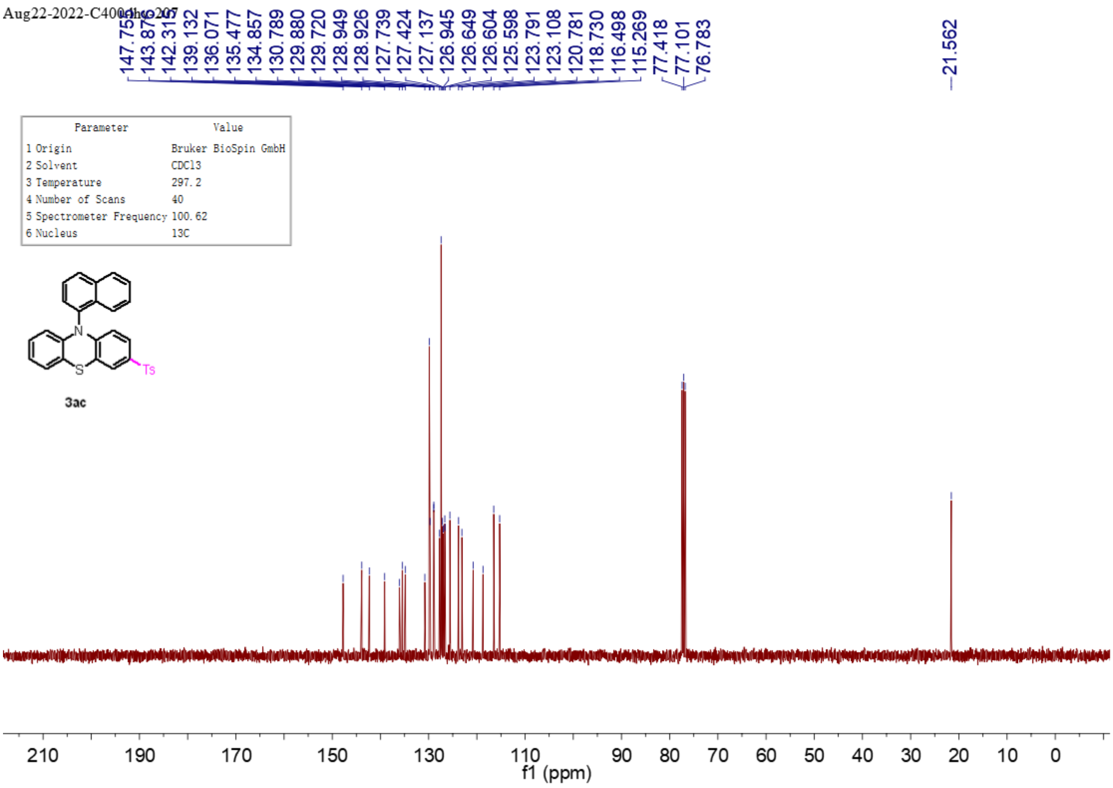


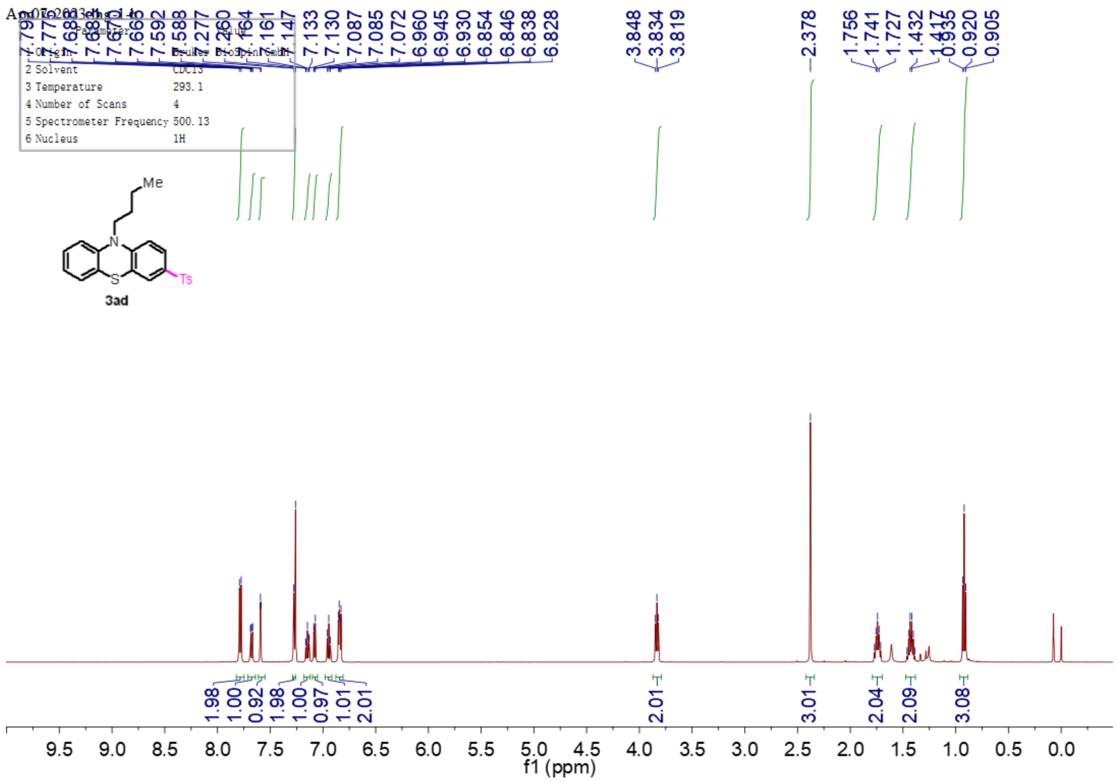
7.260
7.239
7.221
7.217
7.128
7.106
6.839
6.837
6.832
6.162
6.152
6.144
6.138
3.898
2.386
Parameter | Value
1 Origin | Bruker BioSpin GmbH
2 Solvent | CDCl3
3 Temperature | 298.1
4 Number of Scans | 2
5 Spectrometer Frequency | 400.13
6 Nucleus | 1H
OMe
N
S
Ts
3ab
2.06
1.06
1.03
4.05
1.91
1.03
1.92
2.00
3.09
2.98
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)

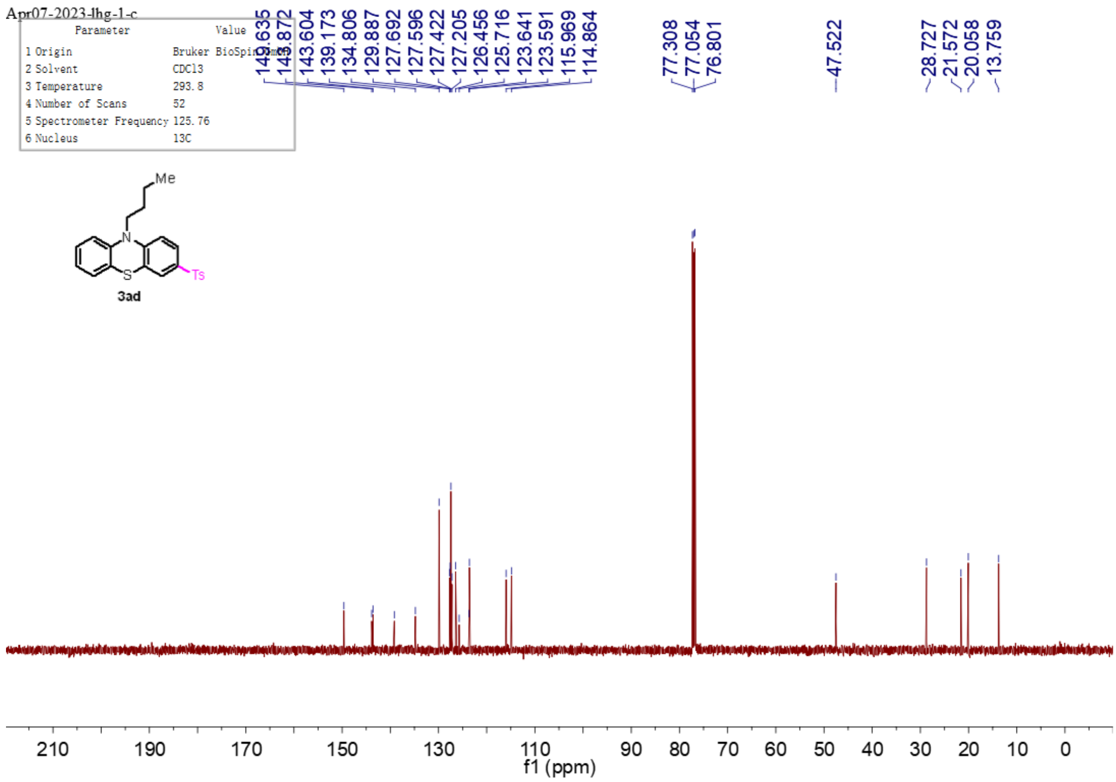


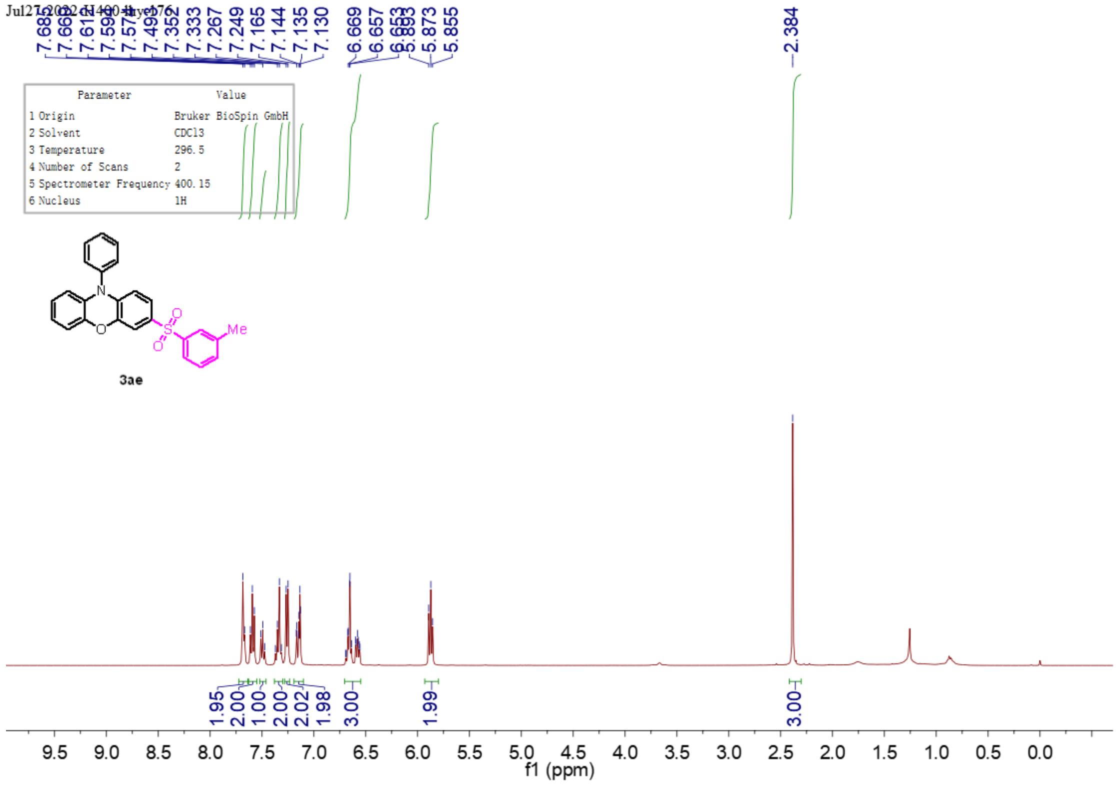
Aug22-2022-C400-lhy-a
159.700
148.591
134.609
132.140
131.696
129.872
127.345
127.305
126.820
126.660
125.623
123.590
120.644
118.628
116.340
116.273
77.428
77.110
76.792
55.619
21.554
Parameter | Value
1 Origin | Bruker BioSpin GmbH
2 Solvent | CDCl3
3 Temperature | 297.2
4 Number of Scans | 40
5 Spectrometer Frequency | 100.62
6 Nucleus | 13C
OMe
N
S
Ts
3ab
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

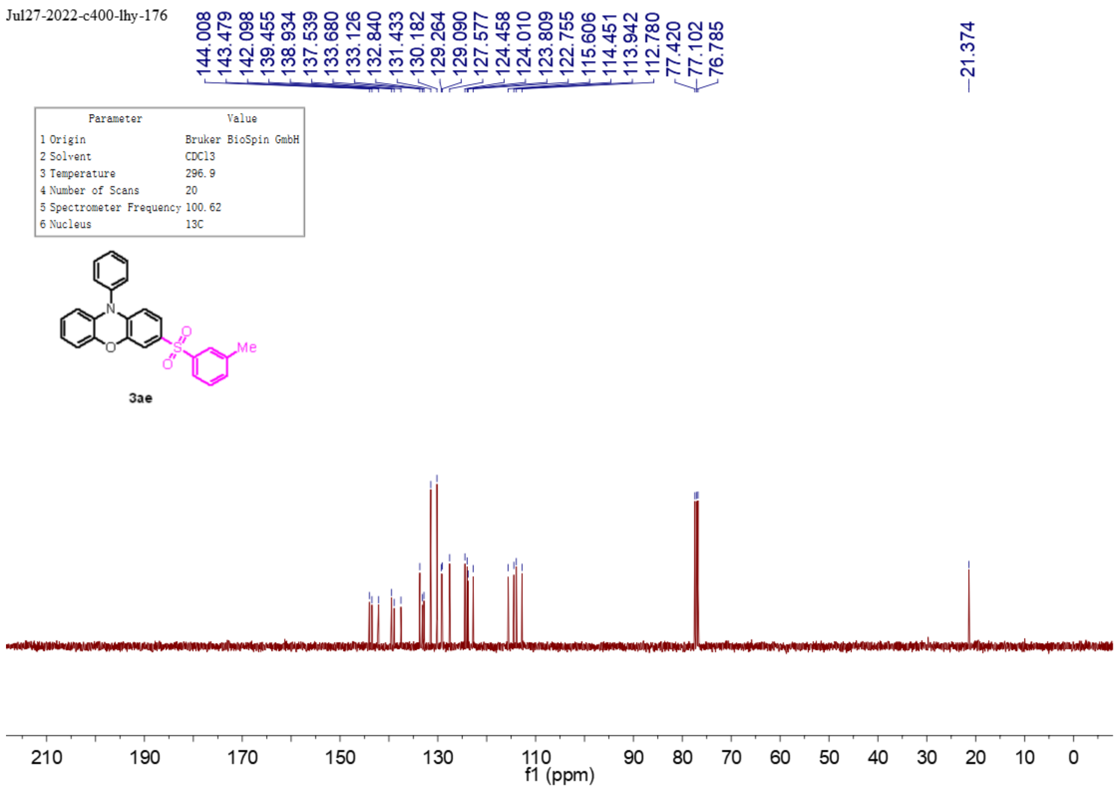

Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 296.7
4 Number of Scans 2
5 Spectrometer Frequency 400.15
6 Nucleus 1H
Ts
3ac
7.741 7.676 7.658 7.638 7.568 7.554 7.552 7.537 7.534 7.531 7.523 7.517 7.476 7.473 7.458 7.455 7.452 7.266 7.260 7.246 7.214 7.208 7.192 7.186 6.983 6.979 6.964 6.960 6.821 6.806 6.803 6.787 6.784 6.716 6.712 6.695 6.692 5.981 5.979 5.972 5.961 5.958 5.950 2.373
3.04 2.00 1.00 2.07 0.92 1.02 2.00 1.00 0.98 1.00 1.00 2.00 3.00
f1 (ppm)

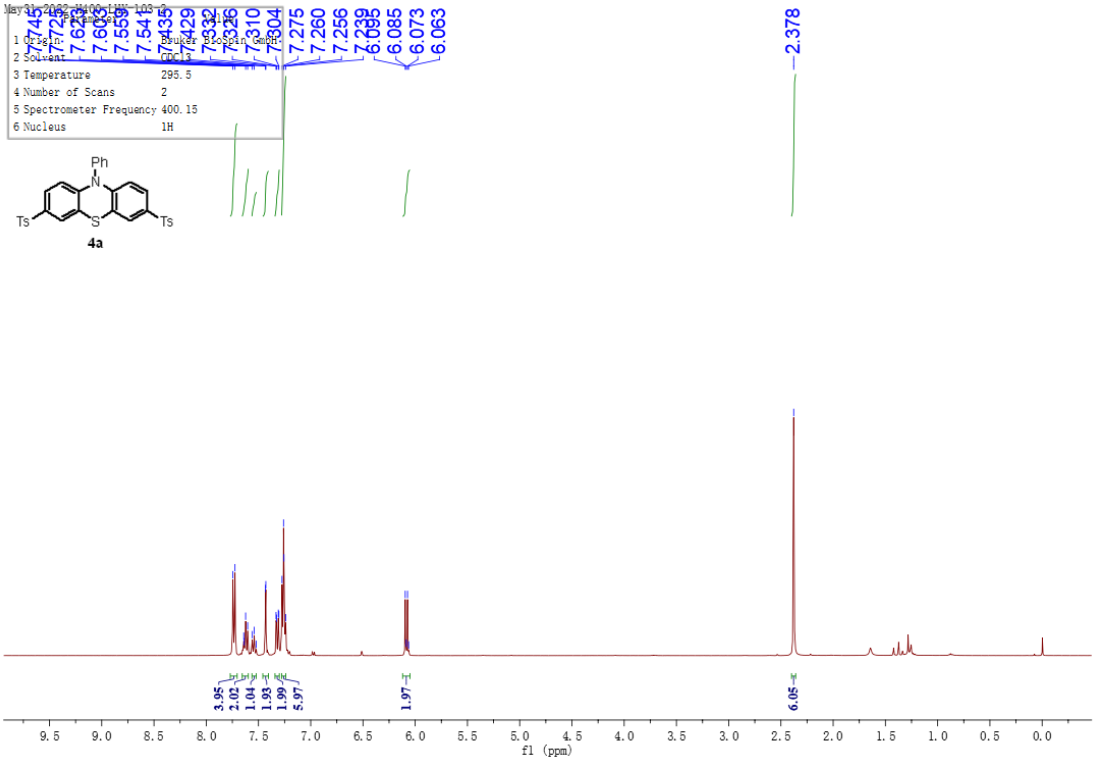

Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 297.2
4 Number of Scans 40
5 Spectrometer Frequency 100.62
6 Nucleus 13C
Ts
3ac
139.132 136.071 135.477 134.857 130.789 129.880 129.720 128.949 128.926 127.739 127.424 127.137 126.945 126.649 126.604 125.598 123.791 123.108 120.781 118.730 116.498 115.269 77.418 77.101 76.783 21.562
f1 (ppm)

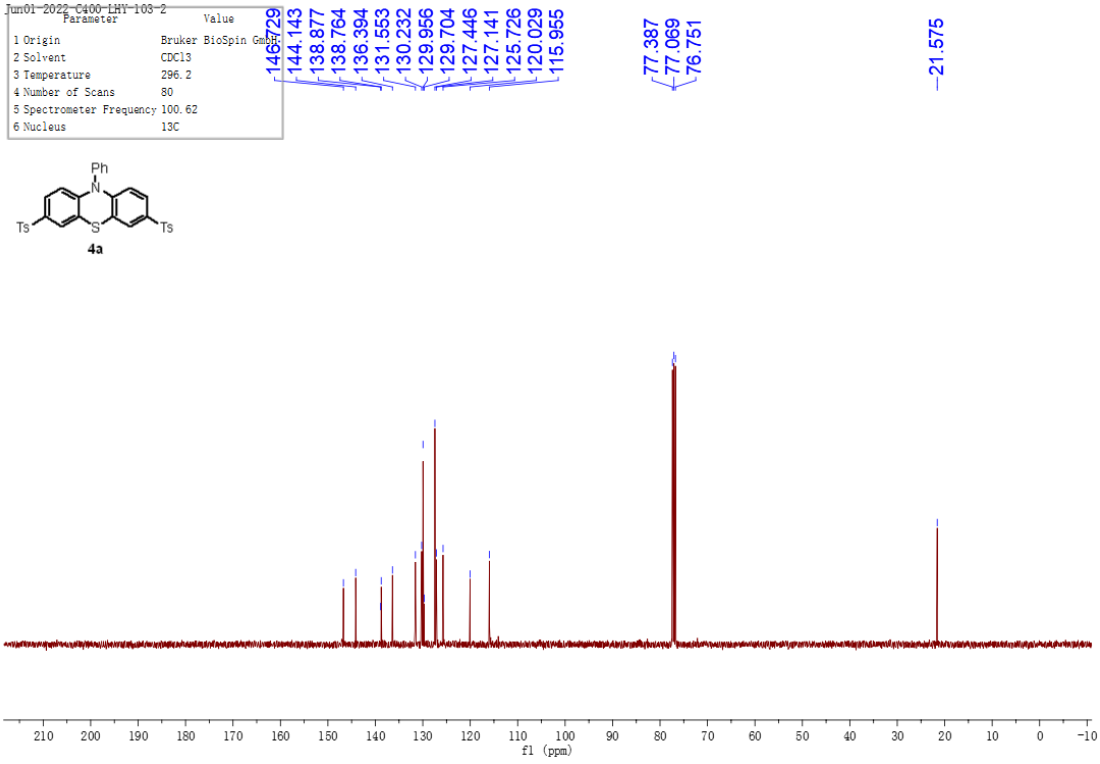

Apr07-2023-lhg-1-h
2 Solvent CDCl3
3 Temperature 293.1
4 Number of Scans 4
5 Spectrometer Frequency 500.13
6 Nucleus 1H
7.665
7.592
7.583
7.277
7.260
7.164
7.161
7.147
7.133
7.130
7.087
7.085
7.072
6.960
6.945
6.930
6.854
6.846
6.838
6.828
3.848
3.834
3.819
2.378
1.756
1.741
1.727
1.432
1.417
0.935
0.920
0.905
Me
N
S
Ts
3ad
1.98
1.00
0.92
1.98
1.00
0.97
1.01
2.01
2.01
3.01
2.04
2.09
3.08
f1 (ppm)

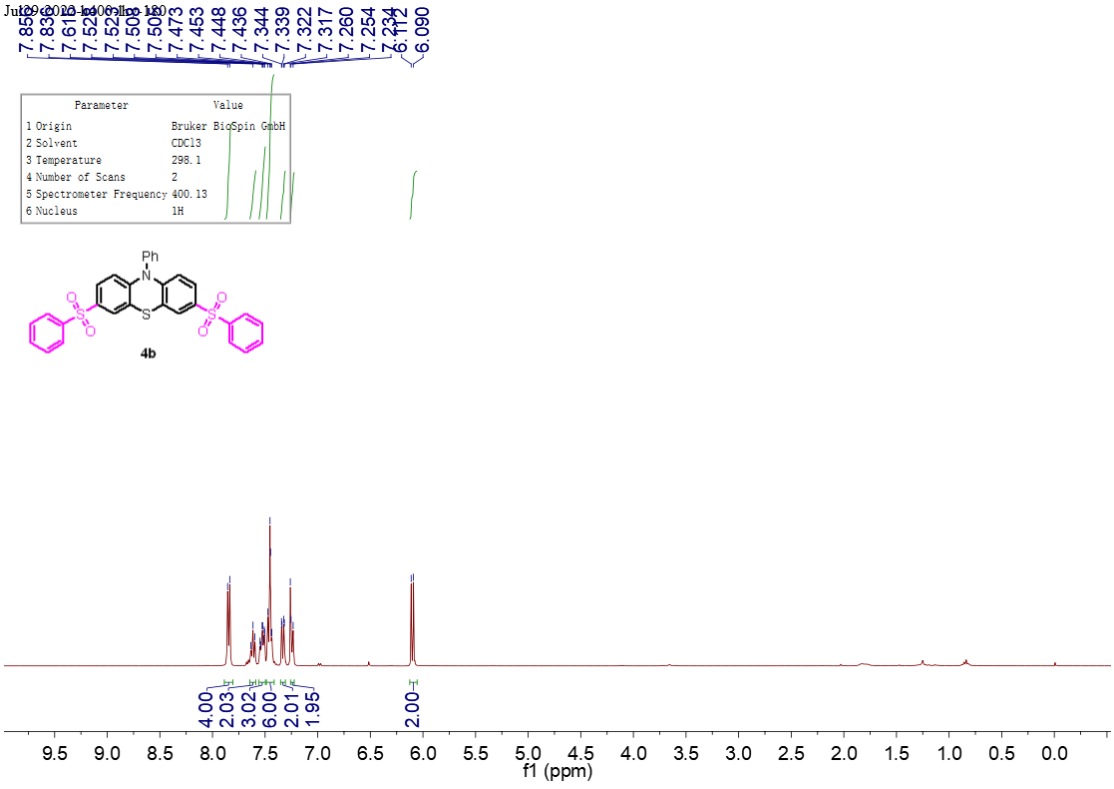

Apr07-2023-lhg-1-c
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 293.8
4 Number of Scans 52
5 Spectrometer Frequency 125.76
6 Nucleus 13C
149.635
143.872
143.604
139.173
134.806
129.887
127.692
127.596
127.422
127.205
126.456
125.716
123.641
123.591
115.969
114.864
77.308
77.054
76.801
47.522
28.727
21.572
20.058
13.759
Me
N
S
Ts
3ad
f1 (ppm)

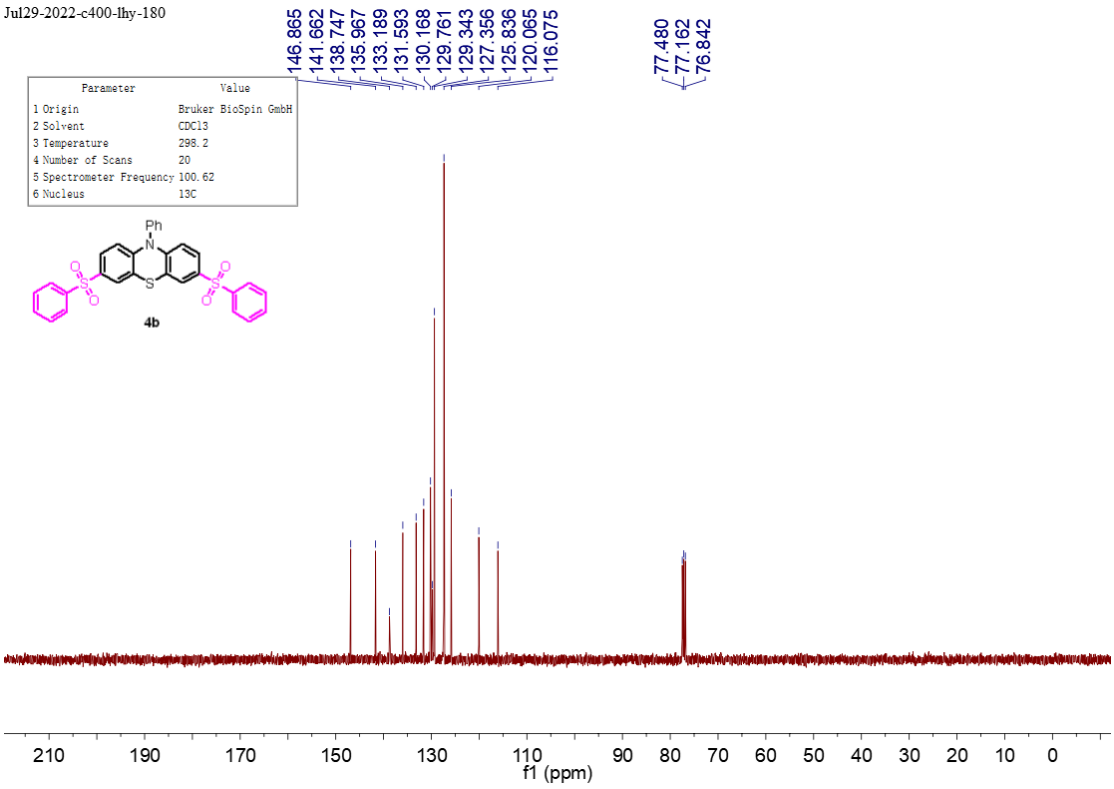

Jul27-2022-c400-lhy-176
7.612
7.333
7.267
7.249
7.165
7.144
7.135
7.130
6.669
6.657
5.873
5.855
2.384
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 296.5
4 Number of Scans 2
5 Spectrometer Frequency 400.15
6 Nucleus 1H
Me
3ae
1.95
2.00
1.00
2.00
2.02
1.98
3.00
1.99
3.00
f1 (ppm)

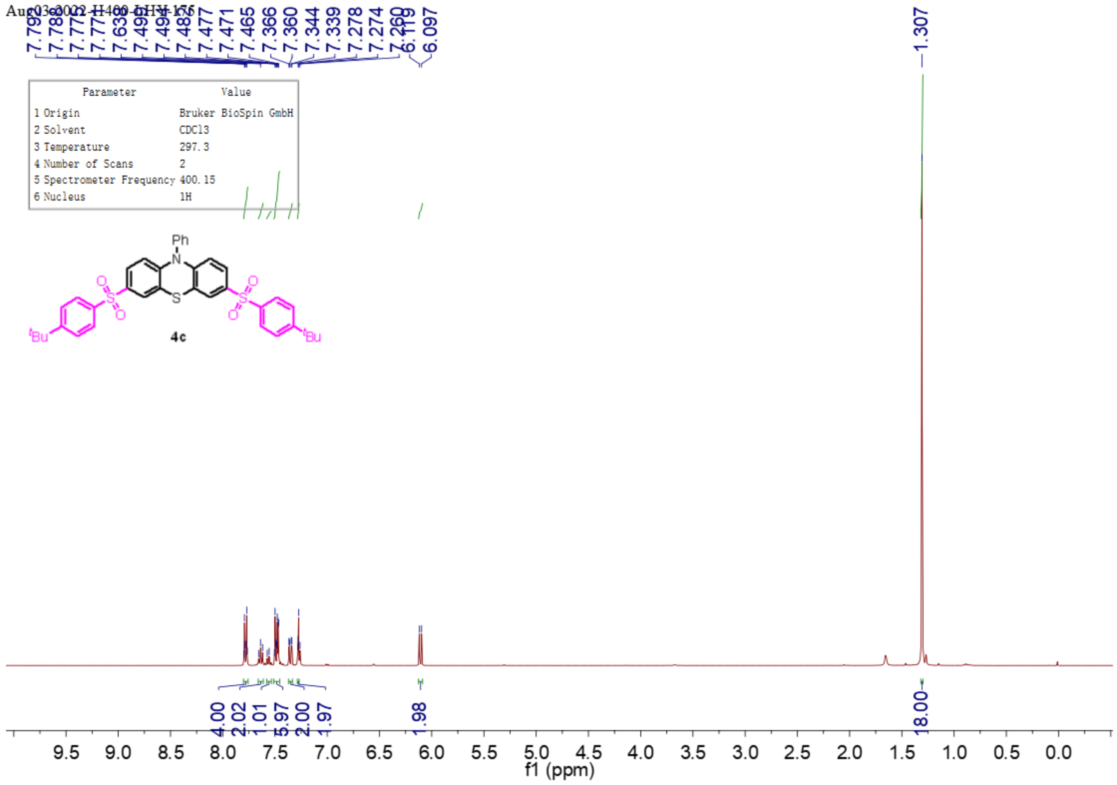

Jul27-2022-c400-lhy-176
144.008
143.479
142.098
139.455
138.934
137.539
133.680
133.126
132.840
131.433
130.182
129.264
129.090
127.577
124.458
124.010
123.809
122.755
115.606
114.451
113.942
112.780
77.420
77.102
76.785
21.374
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 296.9
4 Number of Scans 20
5 Spectrometer Frequency 100.62
6 Nucleus 13C
Me
3ae
f1 (ppm)

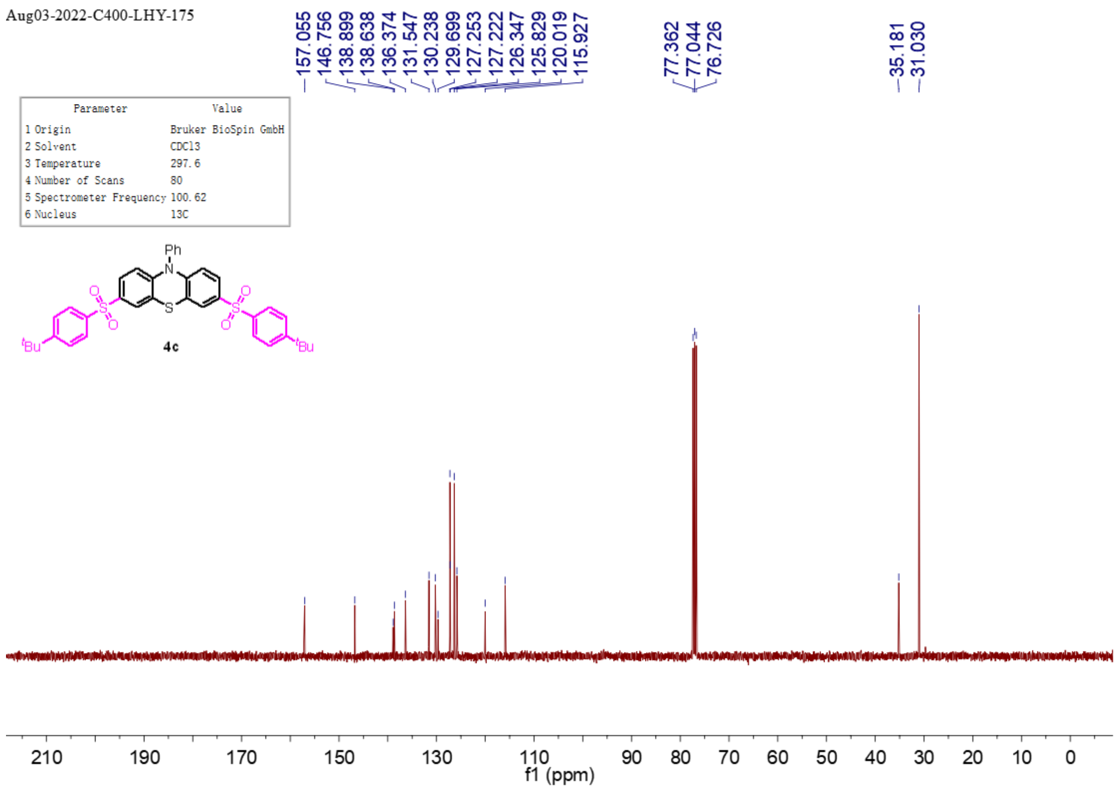

Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 295.5
4 Number of Scans 2
5 Spectrometer Frequency 400.15
6 Nucleus 1H
7.744
7.722
7.627
7.605
7.559
7.541
7.435
7.429
7.332
7.326
7.310
7.304
7.275
7.260
7.256
7.239
6.085
6.073
6.063
2.378
Ph
N
S
Ts
Ts
4a
3.95
2.02
1.04
1.93
1.99
5.97
1.97
6.08
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)


Jun01-2022-C400-LHY-103-2
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 296.2
4 Number of Scans 80
5 Spectrometer Frequency 100.62
6 Nucleus 13C
146.729
144.143
138.877
138.764
136.394
131.553
130.232
129.956
129.704
127.446
127.141
125.726
120.029
115.955
77.387
77.069
76.751
21.575
Ph
N
S
Ts
Ts
4a
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)


7.855
7.838
7.615
7.525
7.508
7.503
7.473
7.453
7.448
7.436
7.344
7.339
7.322
7.317
7.260
7.254
7.234
6.112
6.090
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.1
4 Number of Scans 2
5 Spectrometer Frequency 400.13
6 Nucleus 1H
Ph
N
S
O
O
O
O
4b
4.00
2.03
3.02
6.00
2.01
1.95
2.00
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)

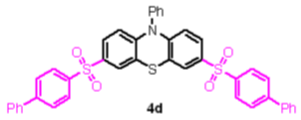

Jul29-2022-c400-lhy-180
146.865
141.662
138.747
135.967
133.189
131.593
130.168
129.761
129.343
127.356
125.836
120.065
116.075
77.480
77.162
76.842
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 20
5 Spectrometer Frequency 100.62
6 Nucleus 13C
Ph
N
S
O
O
O
O
4b
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


Aug03-2022-H400-LHY-175
7.793
7.777
7.771
7.638
7.492
7.482
7.477
7.471
7.465
7.366
7.360
7.344
7.339
7.278
7.274
7.260
6.119
6.097
1.307
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 297.3
4 Number of Scans 2
5 Spectrometer Frequency 400.15
6 Nucleus 1H
Ph
N
S
O
tBu
4c
4.00
2.02
1.01
5.97
2.00
1.97
1.98
18.00
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)

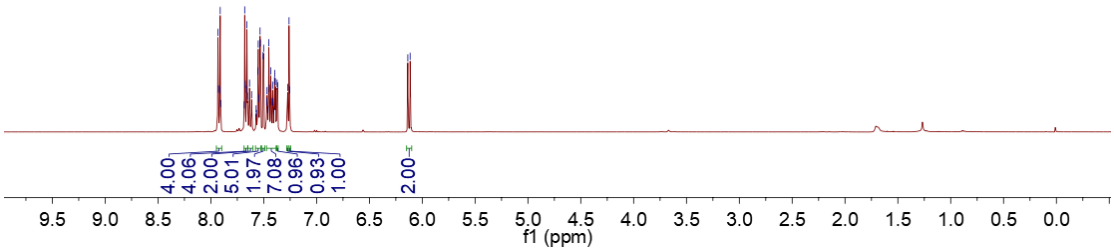

Aug03-2022-C400-LHY-175
157.055
146.756
138.899
138.638
136.374
131.547
130.238
129.699
127.253
127.222
126.347
125.829
120.019
115.927
77.362
77.044
76.726
35.181
31.030
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 297.6
4 Number of Scans 80
5 Spectrometer Frequency 100.62
6 Nucleus 13C
Ph
N
S
O
tBu
4c
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

Aug04-2022-c400-lhy-186-1

Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	297.0
4 Number of Scans	2
5 Spectrometer Frequency	400.13
6 Nucleus	1H

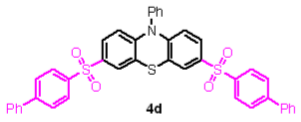


4d

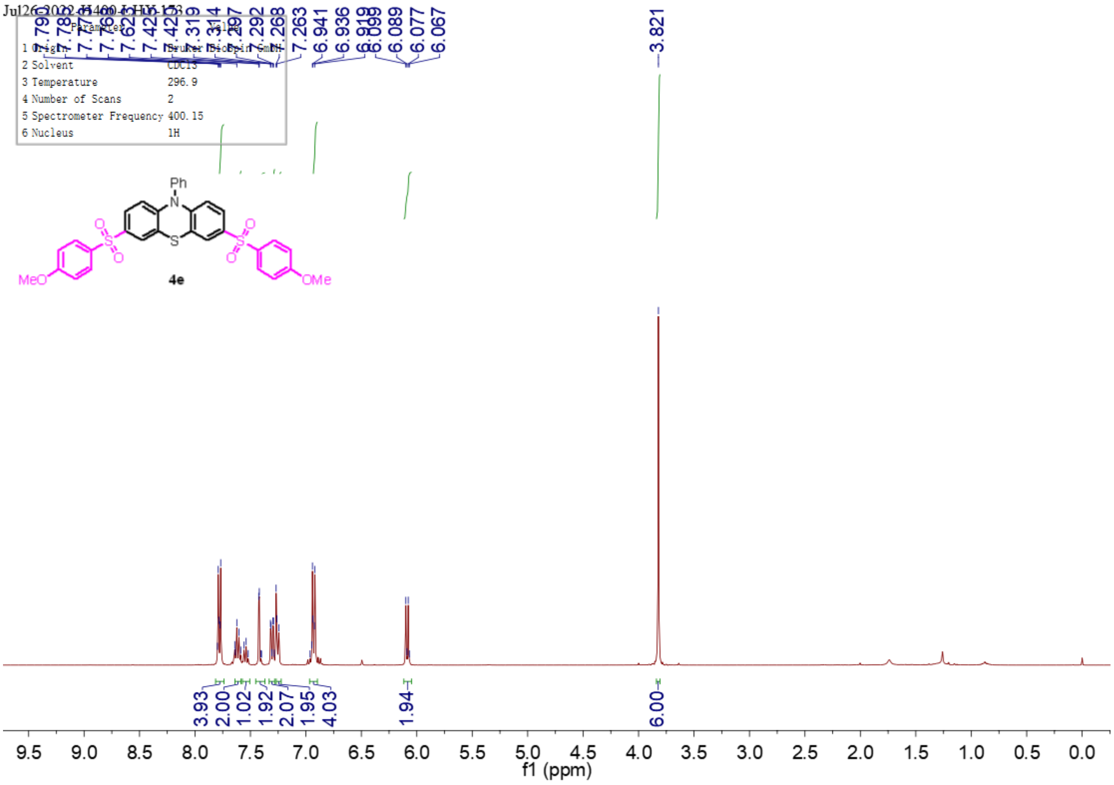


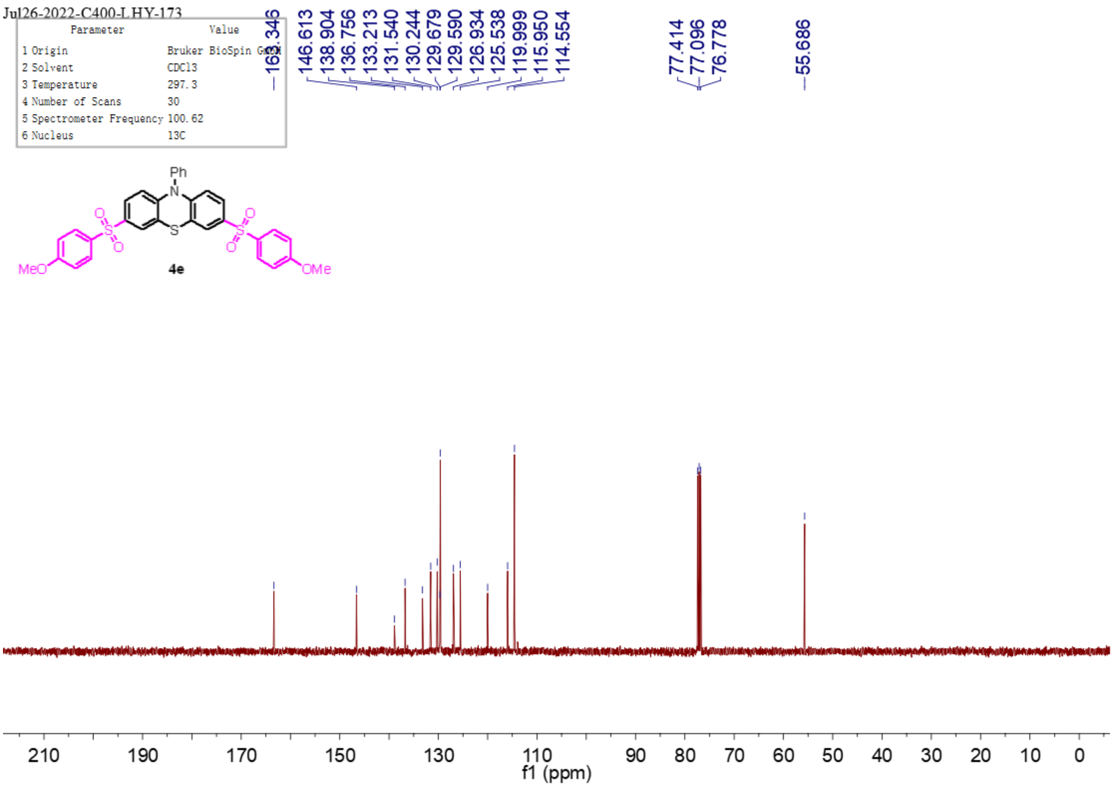
Aug04-2022-c400-lhy-186-1

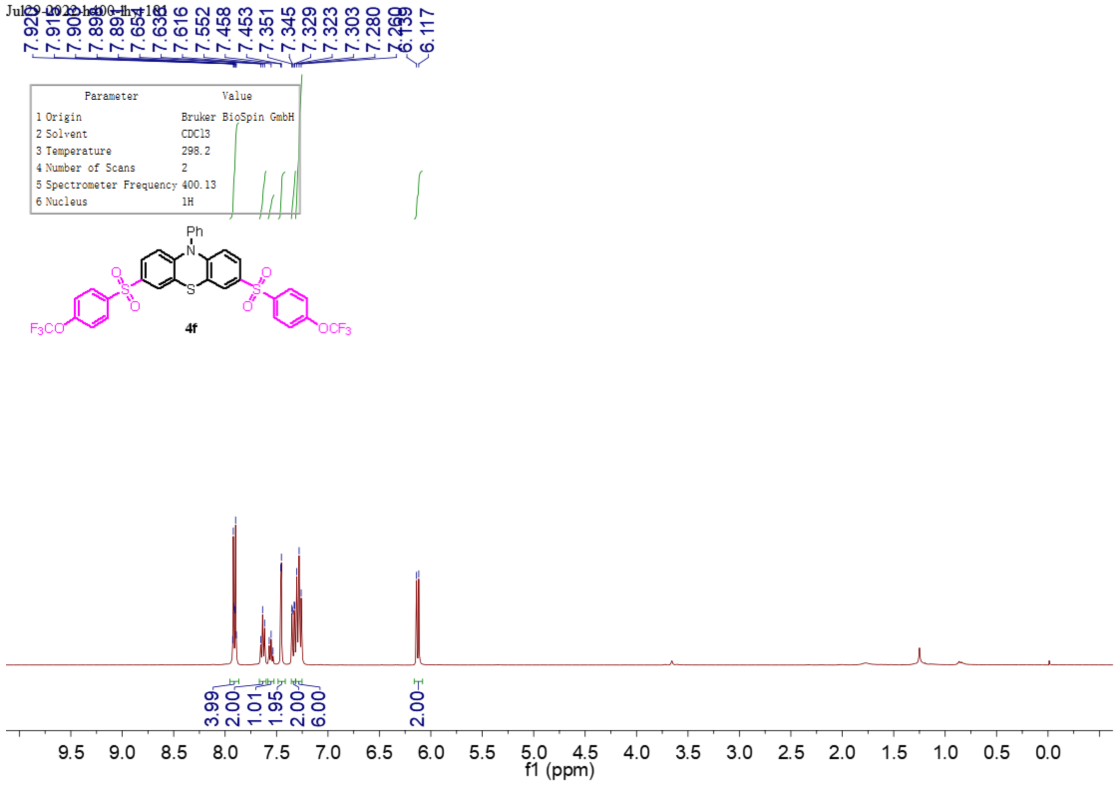
Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	297.8
4 Number of Scans	71
5 Spectrometer Frequency	100.61
6 Nucleus	13C



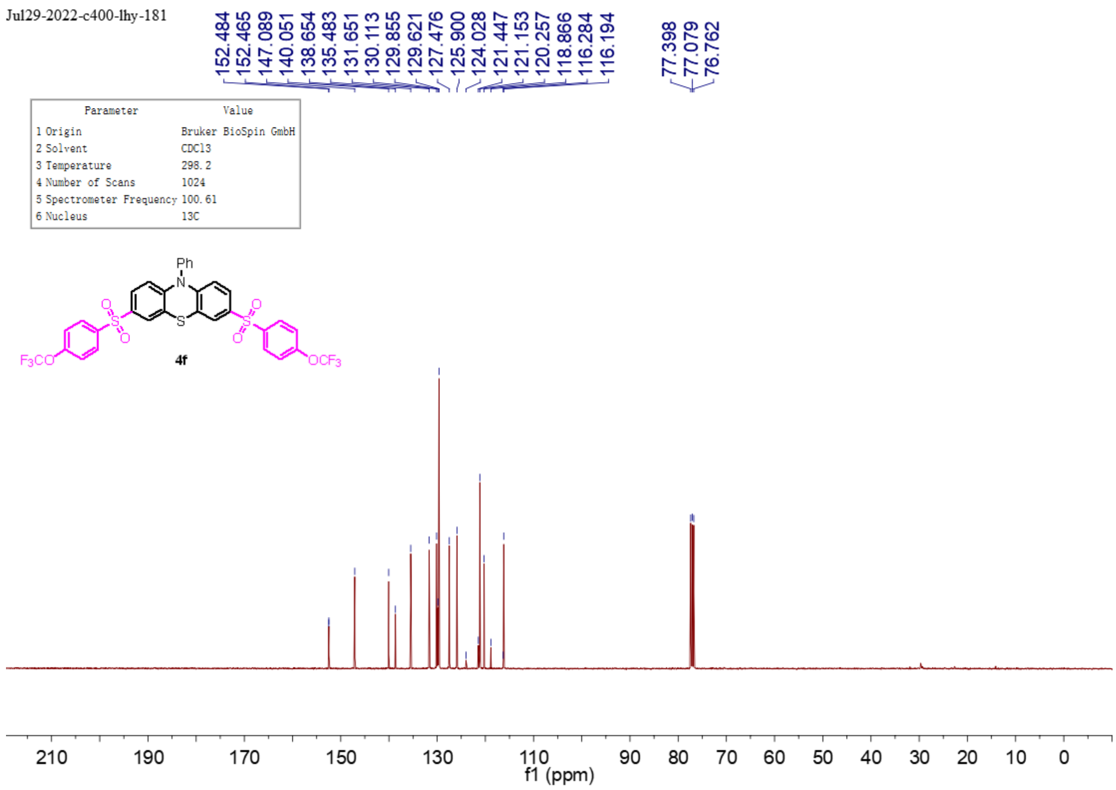
4d


Jul26-2022-H400-LHY-173
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 296.9
4 Number of Scans 2
5 Spectrometer Frequency 400.15
6 Nucleus 1H
7.263
6.941
6.936
6.919
6.099
6.089
6.077
6.067
3.821
Ph
N
S
O
MeO
OMe
4e
3.93
2.00
1.02
1.92
2.07
1.95
4.03
1.94
6.00
f1 (ppm)


Jul26-2022-C400-LHY-173
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 297.3
4 Number of Scans 30
5 Spectrometer Frequency 100.62
6 Nucleus 13C
163.346
146.613
138.904
136.756
133.213
131.540
130.244
129.679
129.590
126.934
125.538
119.999
115.950
114.554
77.414
77.096
76.778
55.686
Ph
N
S
O
MeO
OMe
4e
f1 (ppm)



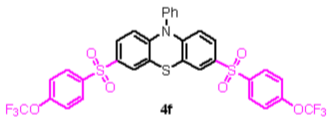
7.920
7.911
7.905
7.899
7.894
7.654
7.638
7.616
7.552
7.458
7.453
7.351
7.345
7.329
7.323
7.303
7.280
7.260
6.139
6.117
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 2
5 Spectrometer Frequency 400.13
6 Nucleus 1H
Ph
N
S
F3CO
OCF3
4f
3.99
2.00
1.01
1.95
2.00
6.00
2.00
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)



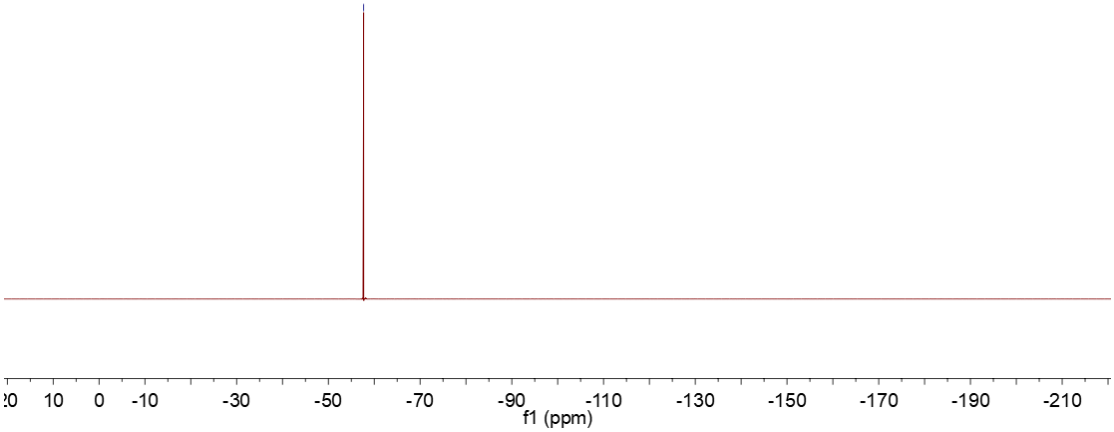
Jul29-2022-c400-lhy-181
152.484
152.465
147.089
140.051
138.654
135.483
131.651
130.113
129.855
129.621
127.476
125.900
124.028
121.447
121.153
120.257
118.866
116.284
116.194
77.398
77.079
76.762
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 1024
5 Spectrometer Frequency 100.61
6 Nucleus 13C
Ph
N
S
F3CO
OCF3
4f
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

Aug01-2022-H400-LHY-181

Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	296.6
4 Number of Scans	2
5 Spectrometer Frequency	376.52
6 Nucleus	19F

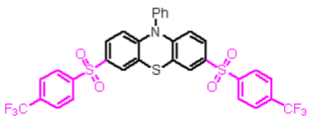


4f

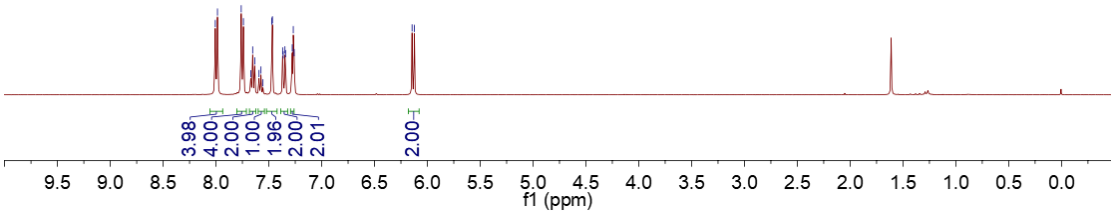


Aug16-2022-c400-lhy-181

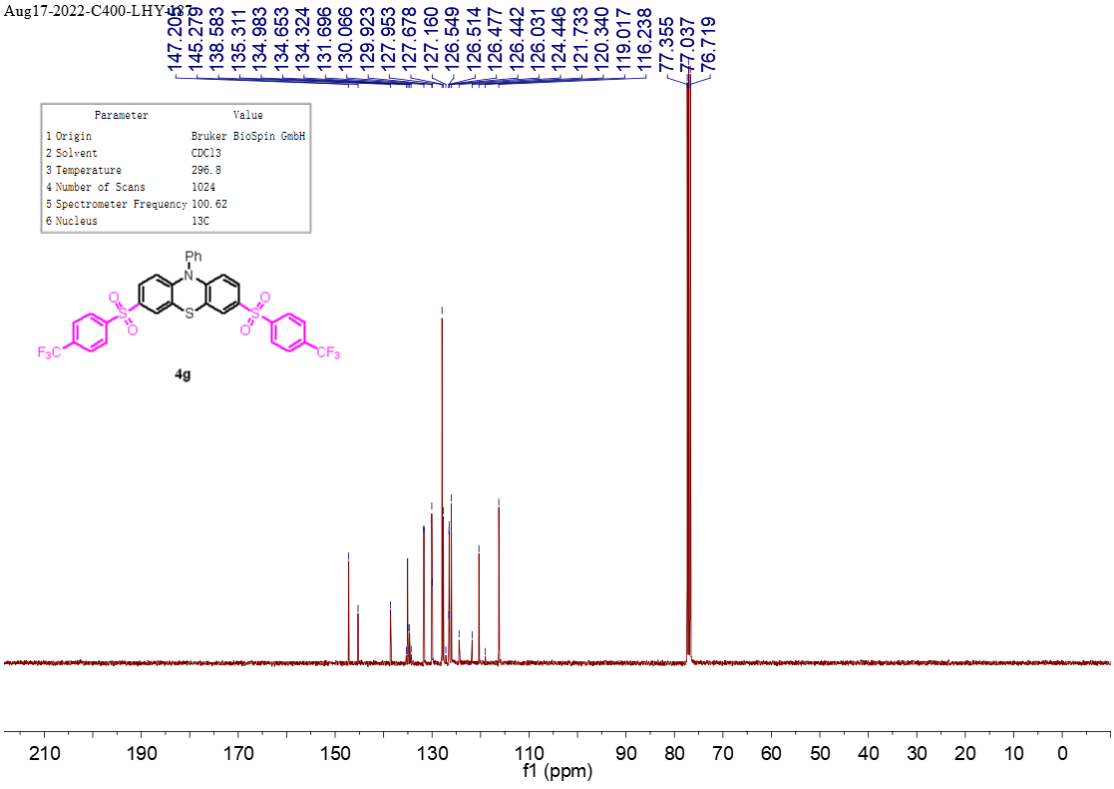
Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	298.2
4 Number of Scans	2
5 Spectrometer Frequency	400.13
6 Nucleus	1H



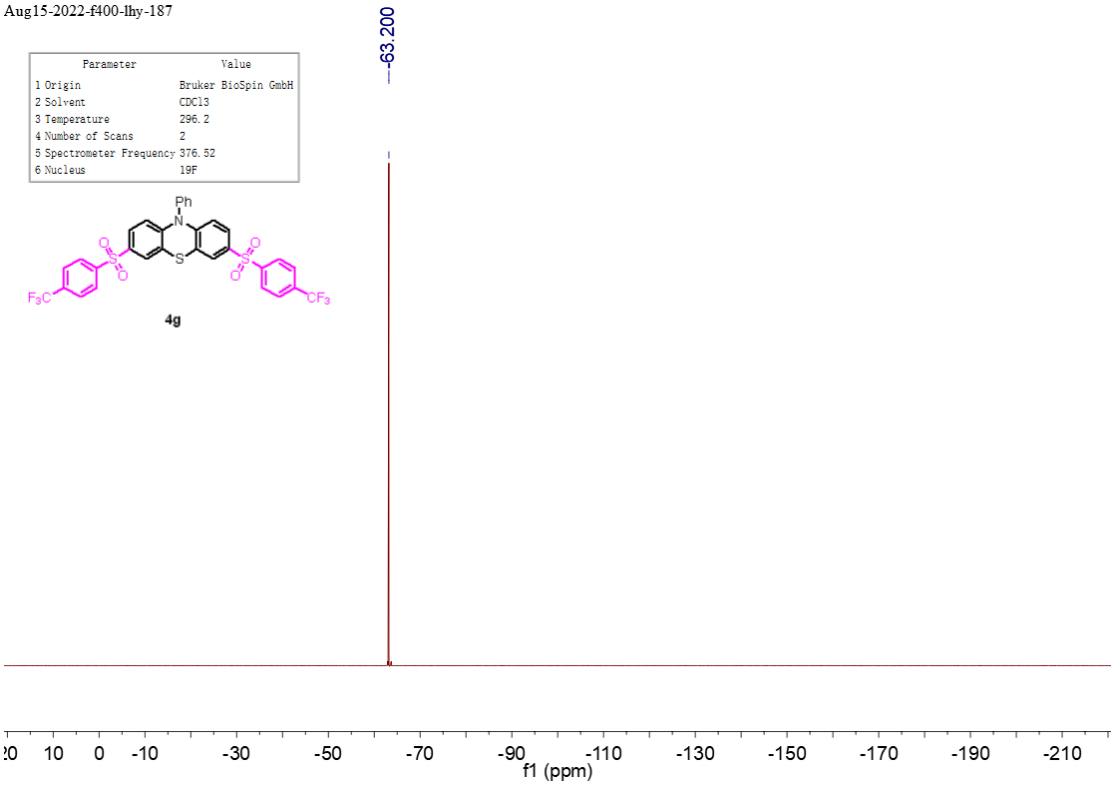
4g

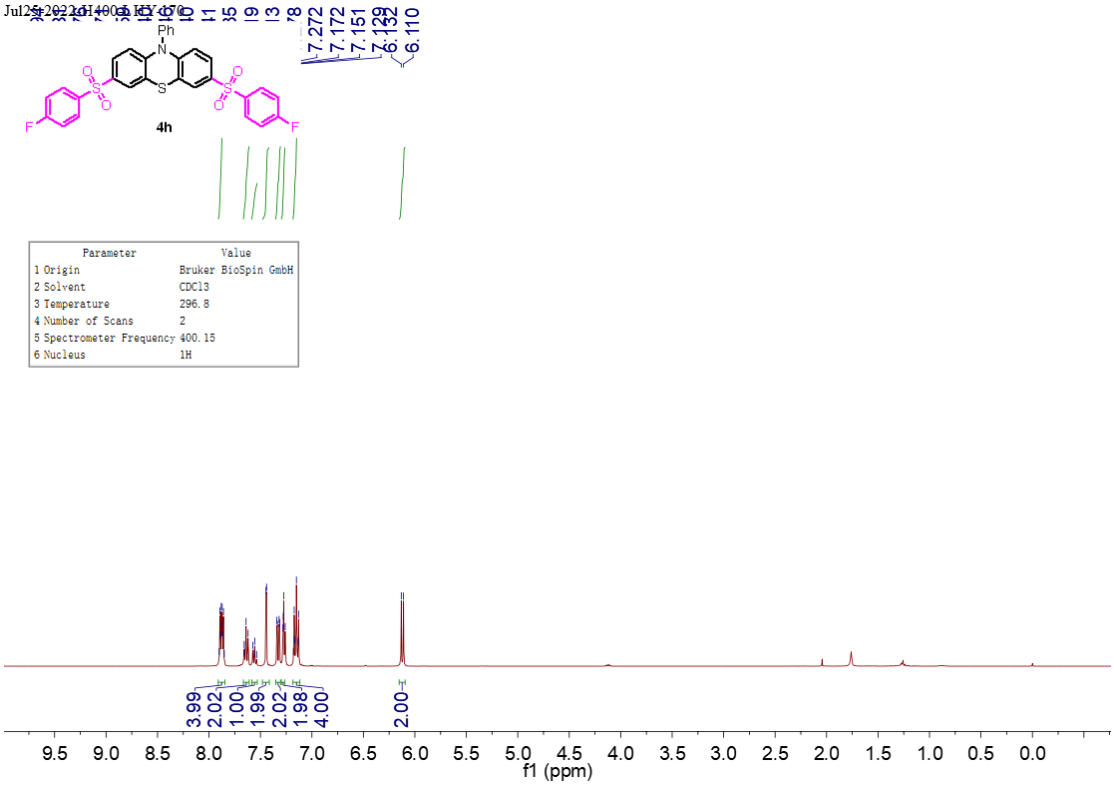


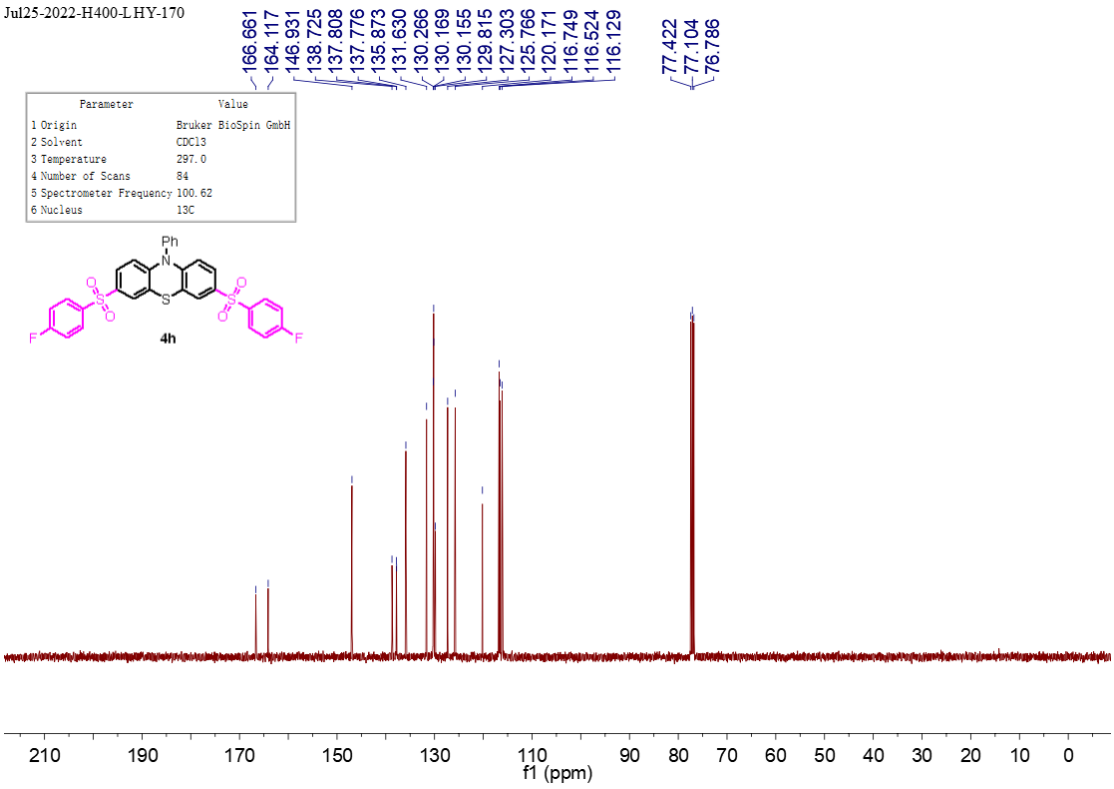
Aug17-2022-C400-LHY-187



Aug15-2022-f400-lhy-187

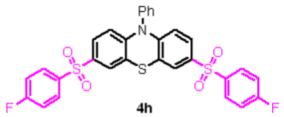



7.272
7.172
7.151
7.129
6.132
6.110
Ph
N
S
F
F
4h
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 296.8
4 Number of Scans 2
5 Spectrometer Frequency 400.15
6 Nucleus 1H
3.99
2.02
1.00
1.99
2.02
1.98
4.00
2.00
f1 (ppm)


Jul25-2022-H400-LHY-170
166.661
164.117
146.931
138.725
137.808
137.776
135.873
131.630
130.266
130.169
130.155
129.815
127.303
125.766
120.171
116.749
116.524
116.129
77.422
77.104
76.786
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 297.0
4 Number of Scans 84
5 Spectrometer Frequency 100.62
6 Nucleus 13C
Ph
N
S
F
F
4h
f1 (ppm)

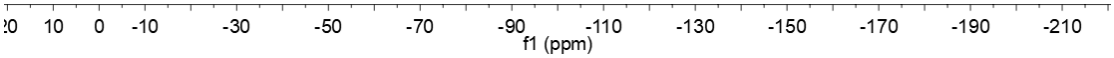
Jul25-2022-H400-LHY-170

Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	296.8
4 Number of Scans	2
5 Spectrometer Frequency	376.52
6 Nucleus	19F



4h

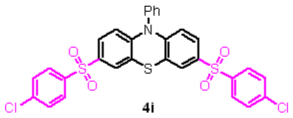
-104.128



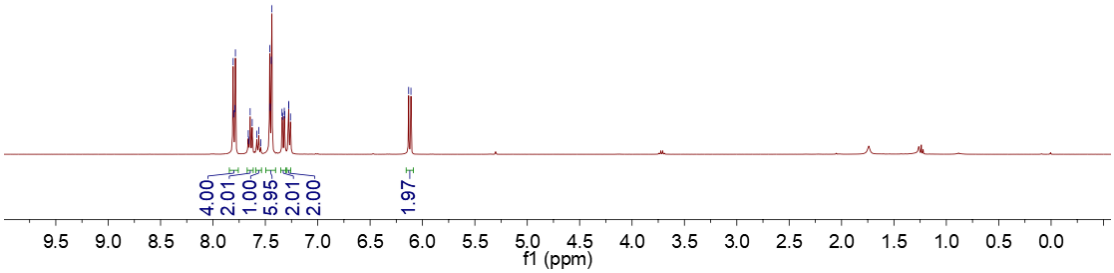
Jul25-2022-H400-LHY-161

7.802
7.800
7.799
7.788
7.644
7.622
7.458
7.454
7.443
7.437
7.341
7.335
7.319
7.314
7.278
7.276
7.260
6.132
6.110

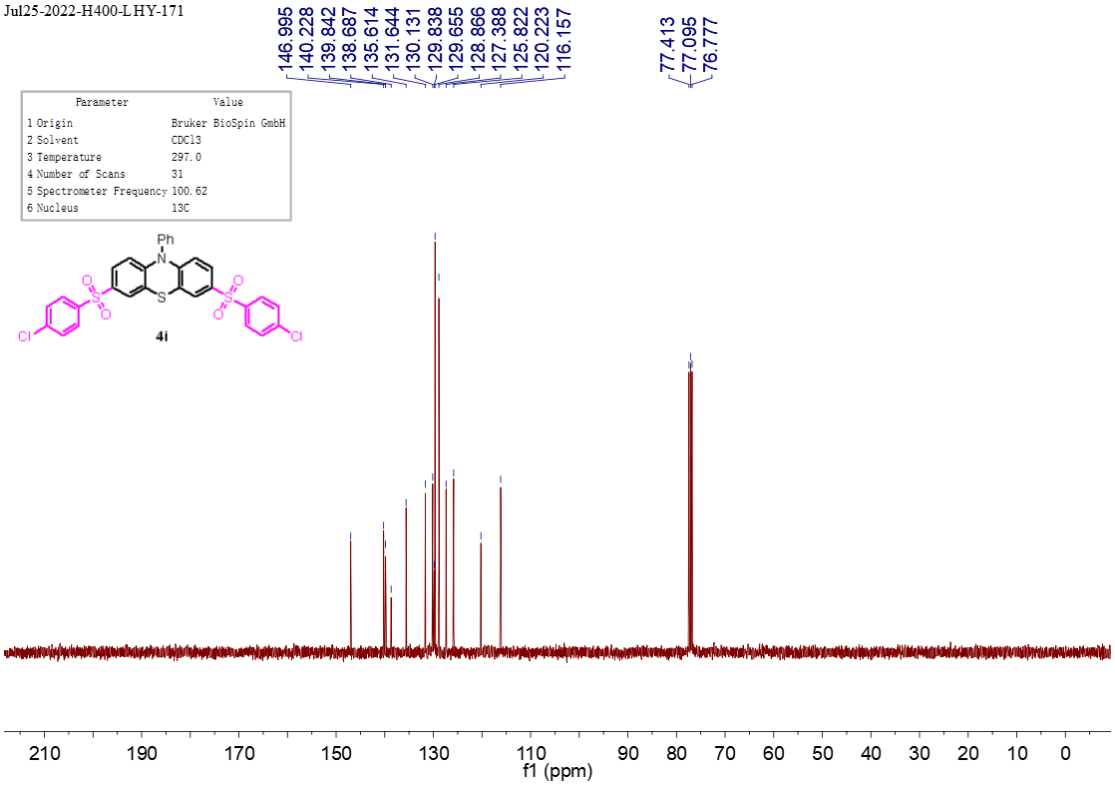
Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	296.8
4 Number of Scans	2
5 Spectrometer Frequency	400.15
6 Nucleus	1H



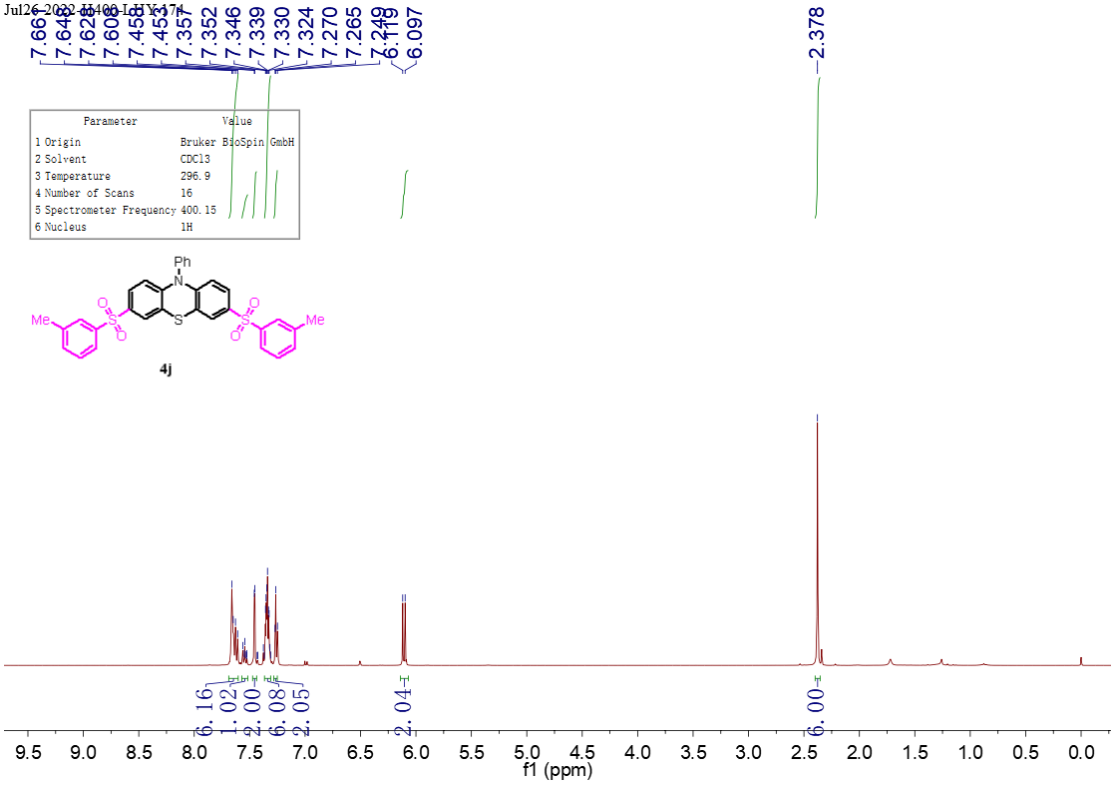
4i



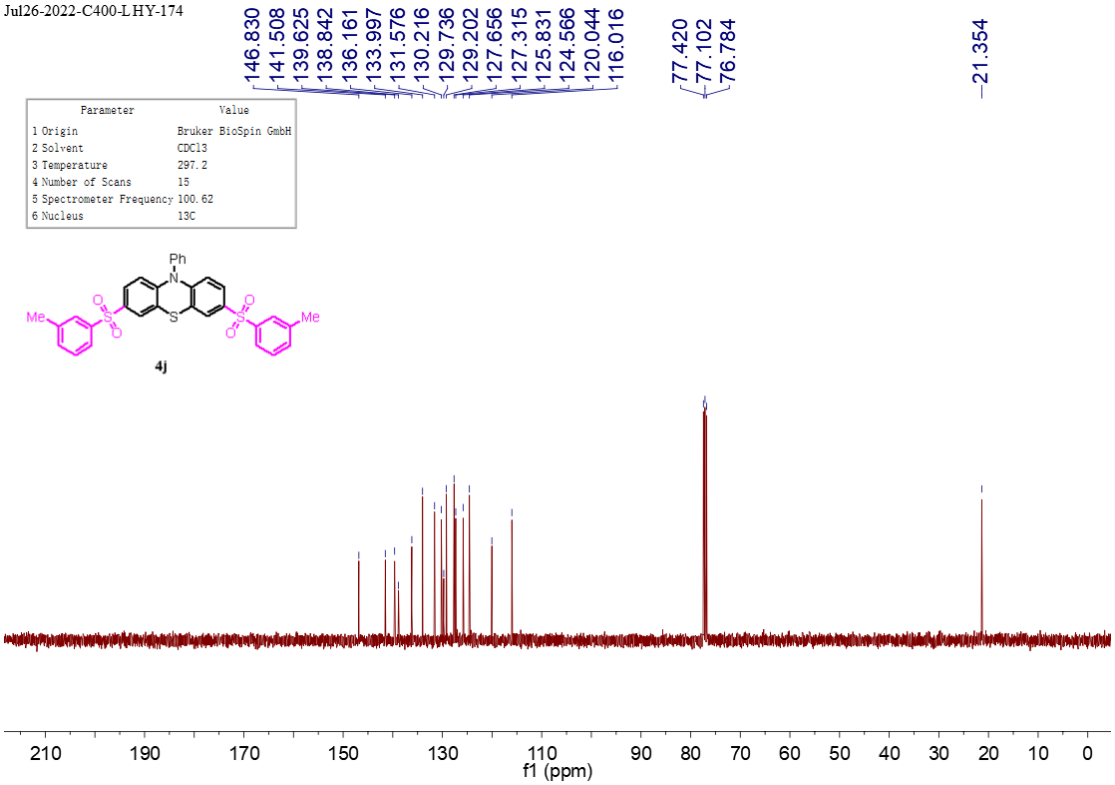
Jul25-2022-H400-LHY-171

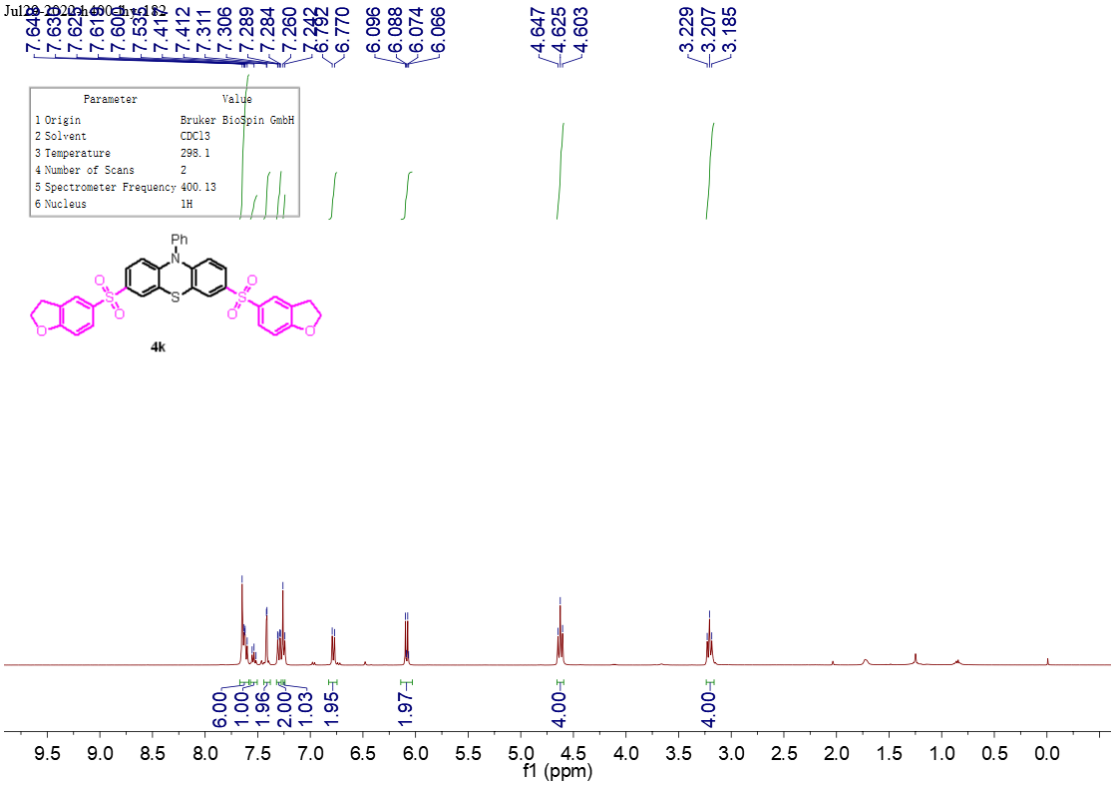


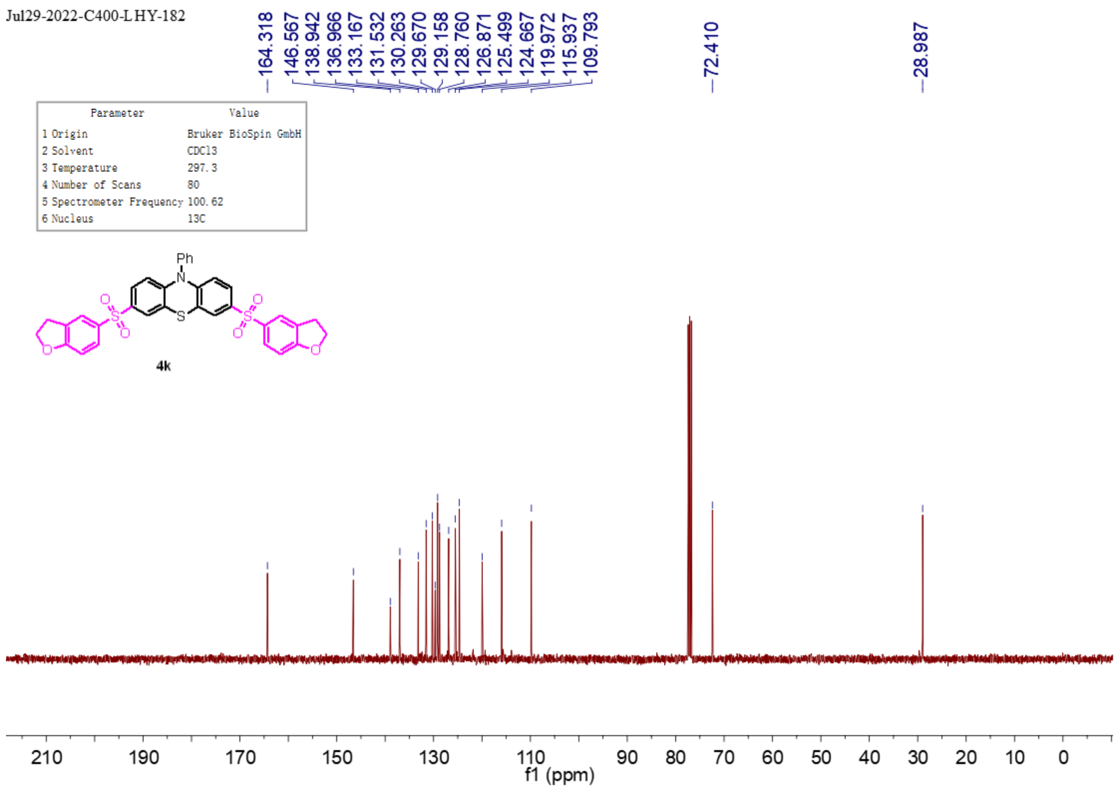
Jul26-2022-H400-LHY-174

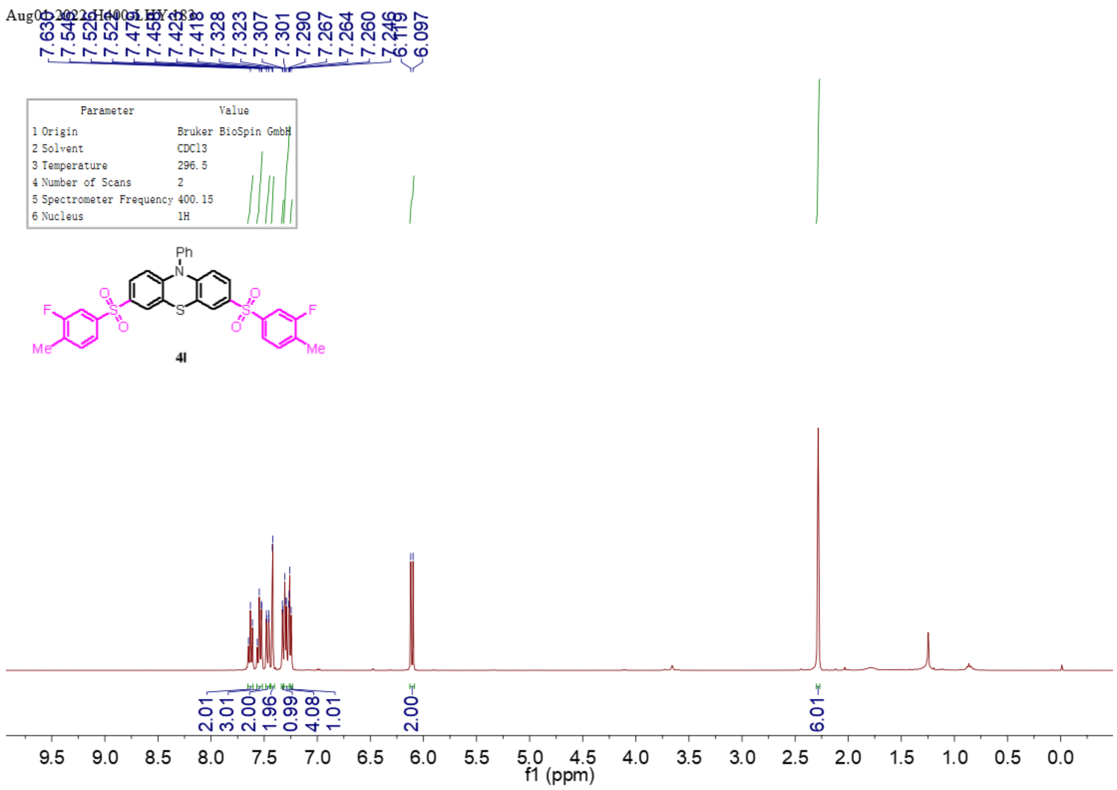


Jul26-2022-C400-LHY-174

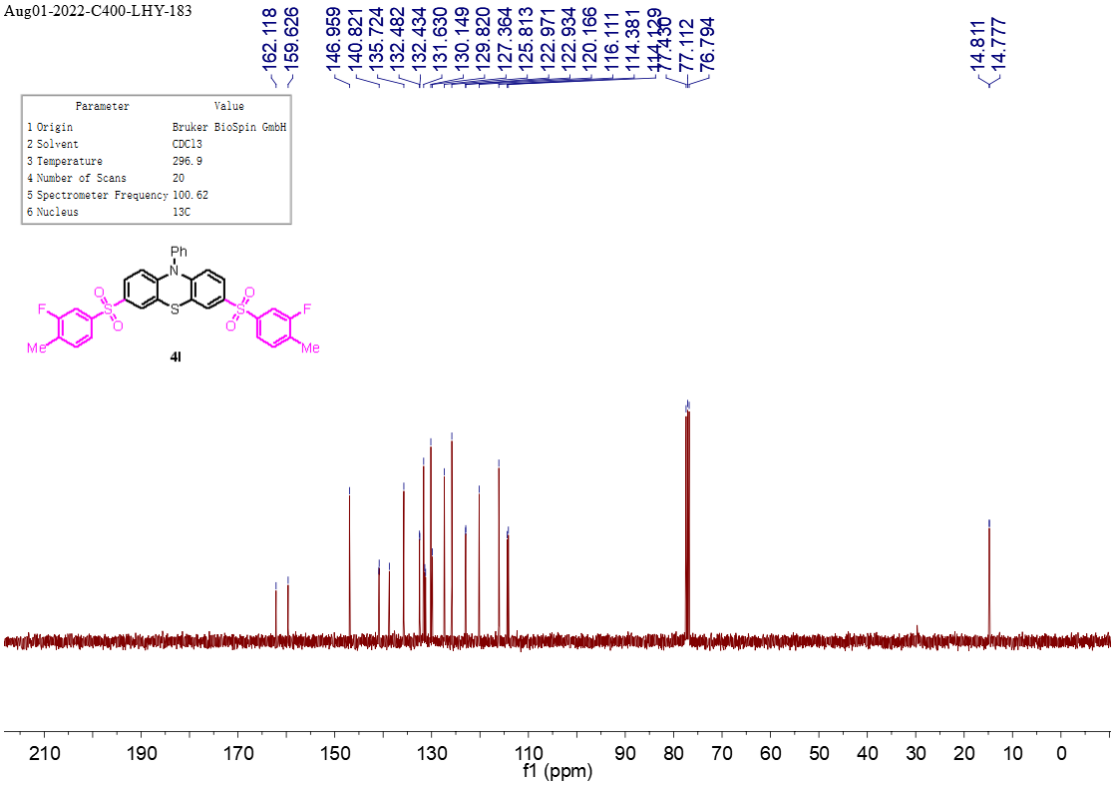




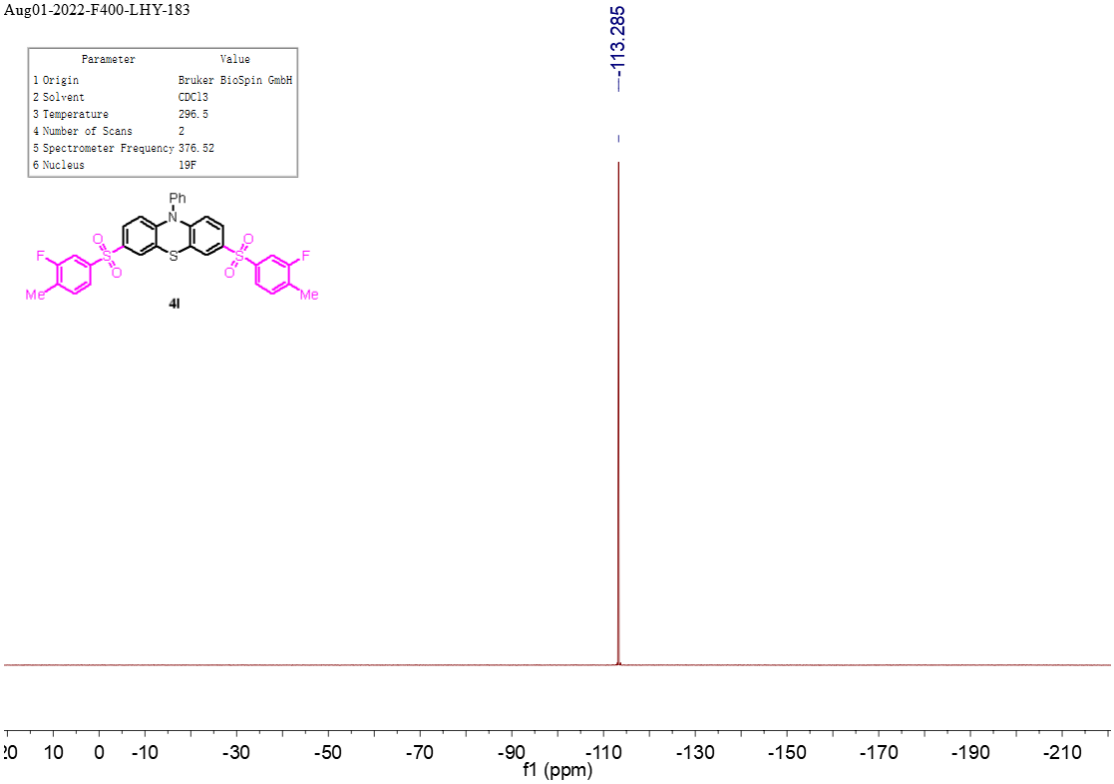

Jul29-2022-C400-LHY-182
164.318
146.567
138.942
136.966
133.167
131.532
130.263
129.670
129.158
128.760
126.871
125.499
124.667
119.972
115.937
109.793
72.410
28.987
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 297.3
4 Number of Scans 80
5 Spectrometer Frequency 100.62
6 Nucleus 13C
Ph
N
S
O
4k
f1 (ppm)


7.328
7.323
7.307
7.301
7.290
7.267
7.264
7.260
6.119
6.097
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 296.5
4 Number of Scans 2
5 Spectrometer Frequency 400.15
6 Nucleus 1H
Ph
N
S
F
Me
4l
2.01
3.01
2.00
1.96
0.99
4.08
1.01
2.00
6.01
f1 (ppm)

Aug01-2022-C400-LHY-183



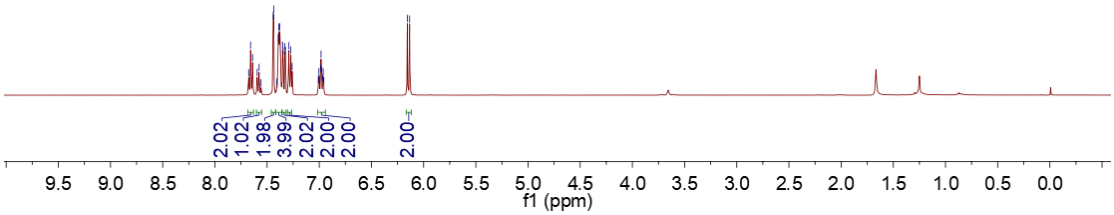
Aug01-2022-F400-LHY-183



Aug05-2022-C400-LHY-184

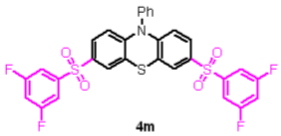
Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	298.2
4 Number of Scans	2
5 Spectrometer Frequency	400.13
6 Nucleus	1H

4m

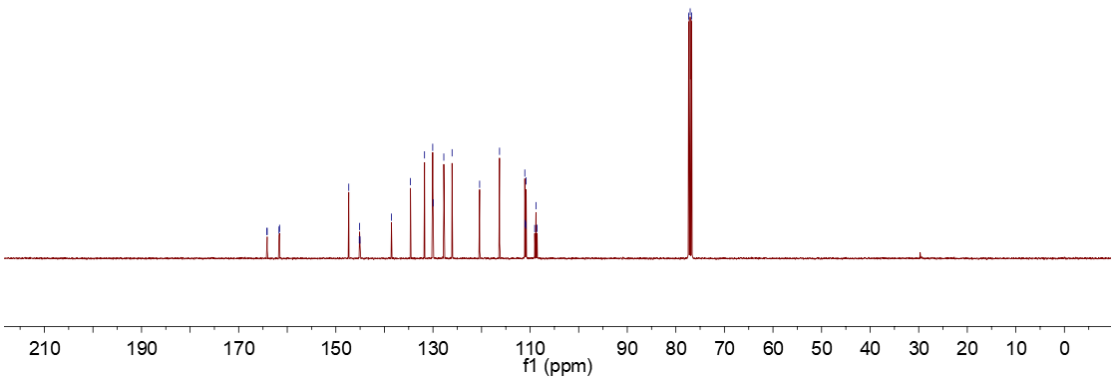


Aug05-2022-C400-LHY-184

Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	297.0
4 Number of Scans	1024
5 Spectrometer Frequency	100.62
6 Nucleus	13C

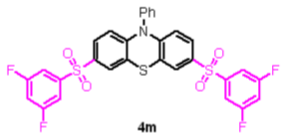


4m



Aug01-2022-F400-LHY-184

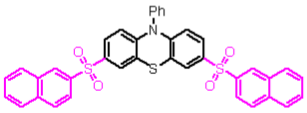
Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	296.6
4 Number of Scans	16
5 Spectrometer Frequency	376.52
6 Nucleus	19F



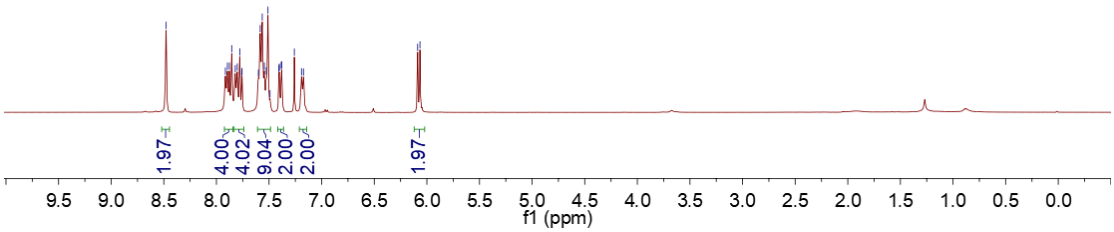
4m

Jul28-2022-h400-lhy-179

Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	298.1
4 Number of Scans	2
5 Spectrometer Frequency	400.13
6 Nucleus	1H



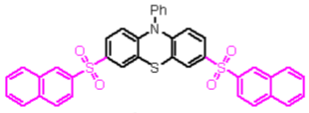
4n



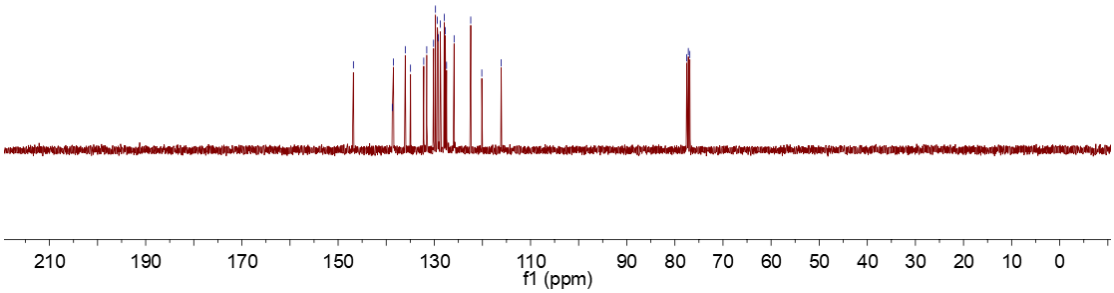
Jul28-2022-c400-lhy-177

146.820
138.738
138.494
136.042
134.942
132.199
131.576
130.154
129.758
129.357
129.191
128.755
127.940
127.714
127.451
125.891
122.432
120.132
116.099
77.526
77.208
76.890

Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	298.2
4 Number of Scans	20
5 Spectrometer Frequency	100.61
6 Nucleus	13C



4n

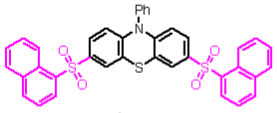


210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

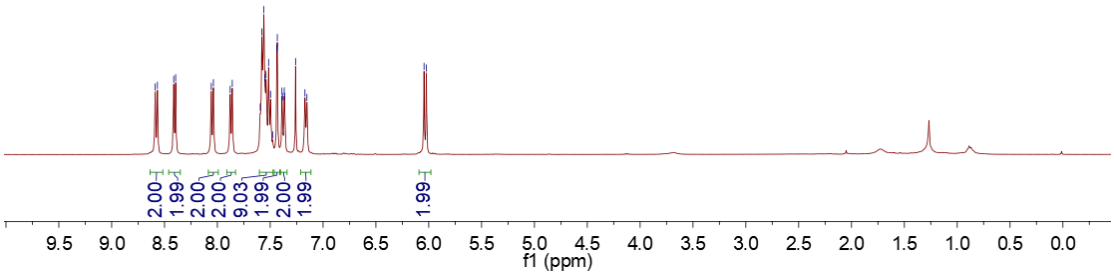
Jul28-2022-c400-lhy-176

8.589
8.561
8.411
8.399
8.055
8.037
7.879
7.859
7.579
7.560
7.549
7.540
7.515
7.437
7.433
7.389
7.367
7.260
6.044
6.023

Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	298.2
4 Number of Scans	2
5 Spectrometer Frequency	400.13
6 Nucleus	1H

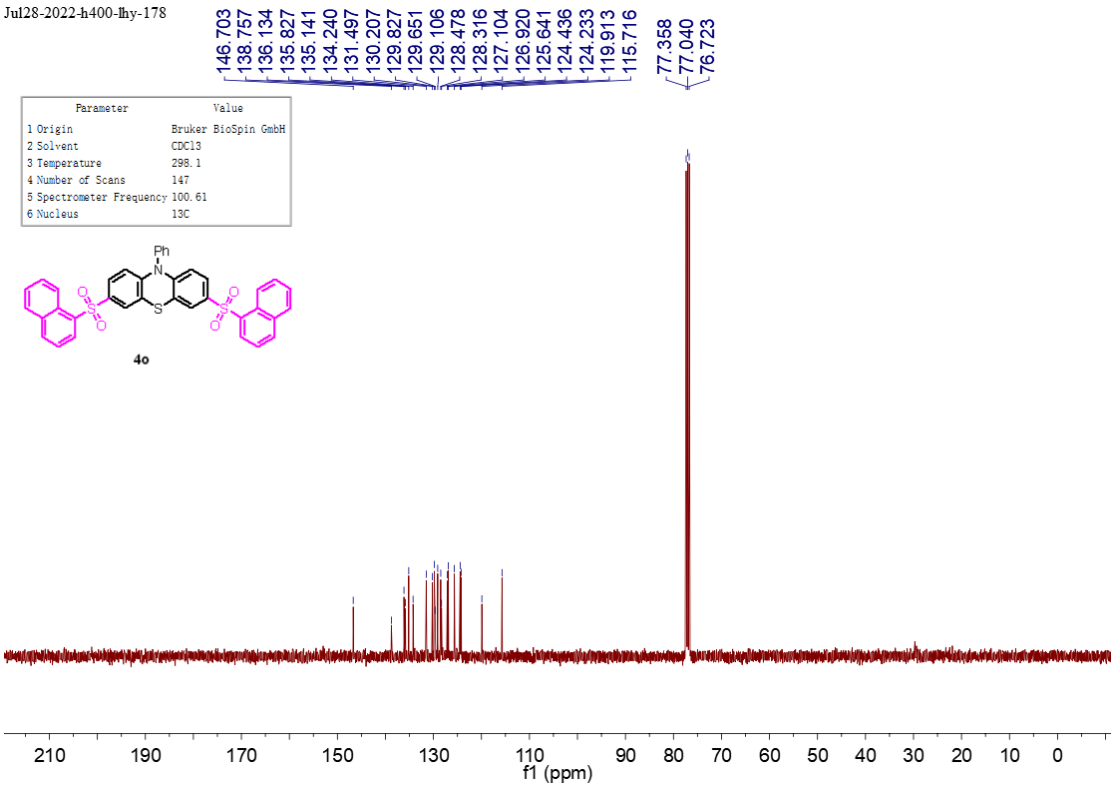


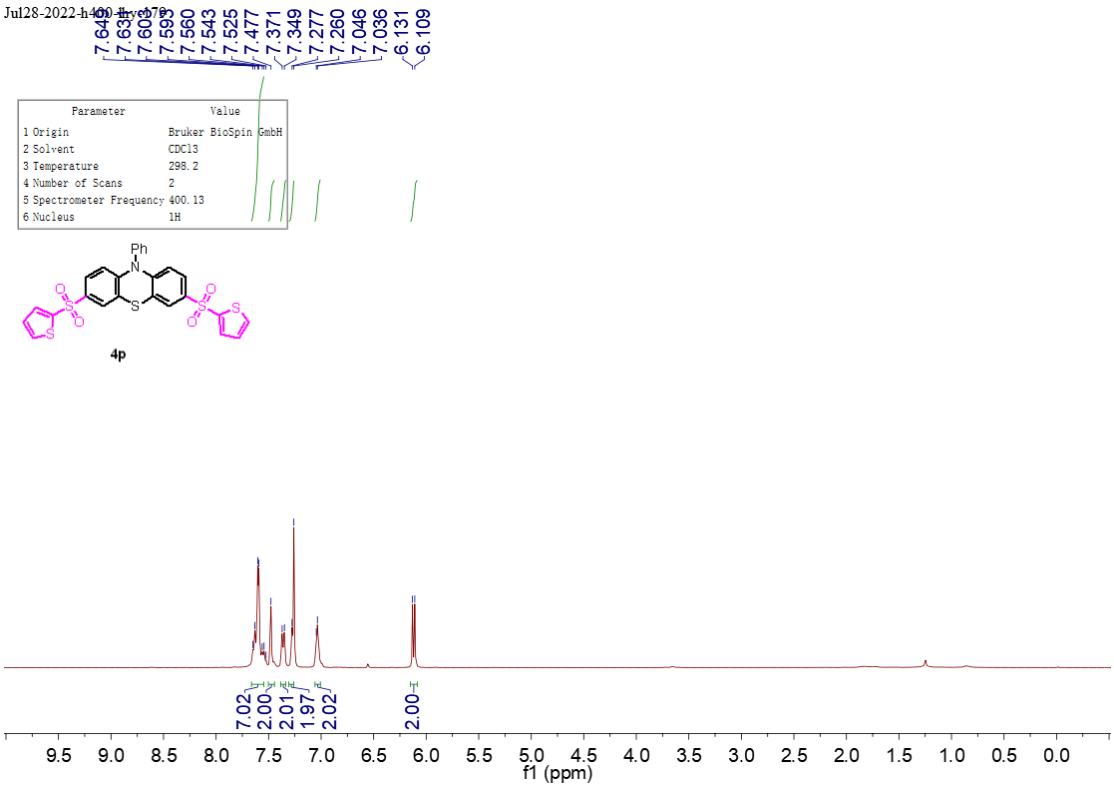
4o



2.00
1.99
2.00
2.00
9.03
1.99
2.00
1.99
1.99

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)


Jul28-2022-h400-lhy-178
146.703
138.757
136.134
135.827
135.141
134.240
131.497
130.207
129.827
129.651
129.106
128.478
128.316
127.104
126.920
125.641
124.436
124.233
119.913
115.716
77.358
77.040
76.723
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.1
4 Number of Scans 147
5 Spectrometer Frequency 100.61
6 Nucleus 13C
Ph
N
S
O
4o
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

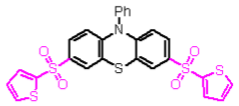

Jul28-2022-h400-lhy-179
7.640
7.633
7.603
7.593
7.560
7.543
7.525
7.477
7.371
7.349
7.277
7.260
7.046
7.036
6.131
6.109
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 2
5 Spectrometer Frequency 400.13
6 Nucleus 1H
Ph
N
S
O
4p
7.02
2.00
2.01
1.97
2.02
2.00
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)

Jul28-2022-c400-lhy-179

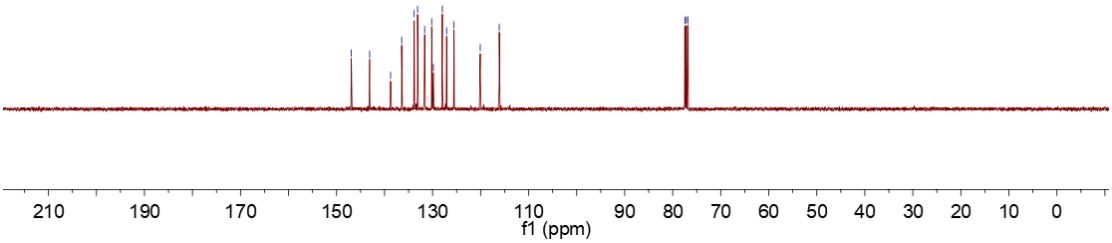
146.920
143.103
138.741
136.435
133.827
133.125
131.651
130.179
129.824
127.962
127.073
125.535
120.070
116.113

77.476
77.157
76.839

Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	298.3
4 Number of Scans	37
5 Spectrometer Frequency	100.61
6 Nucleus	13C



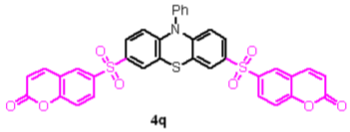
4p



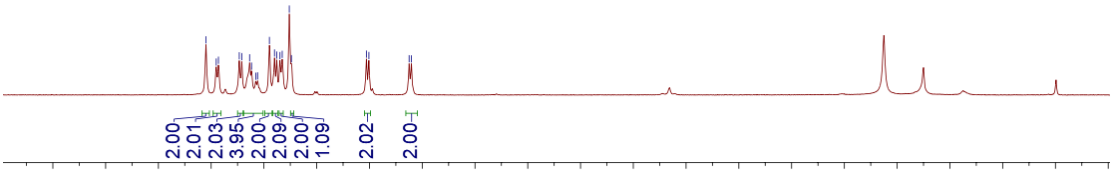
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

8.044
7.957
7.931
7.731
7.711
7.638
7.614
7.575
7.560
7.448
7.400
7.378
7.348
7.327
7.260
7.240
6.529
6.505
6.124
6.103

Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	296.4
4 Number of Scans	2
5 Spectrometer Frequency	400.15
6 Nucleus	1H



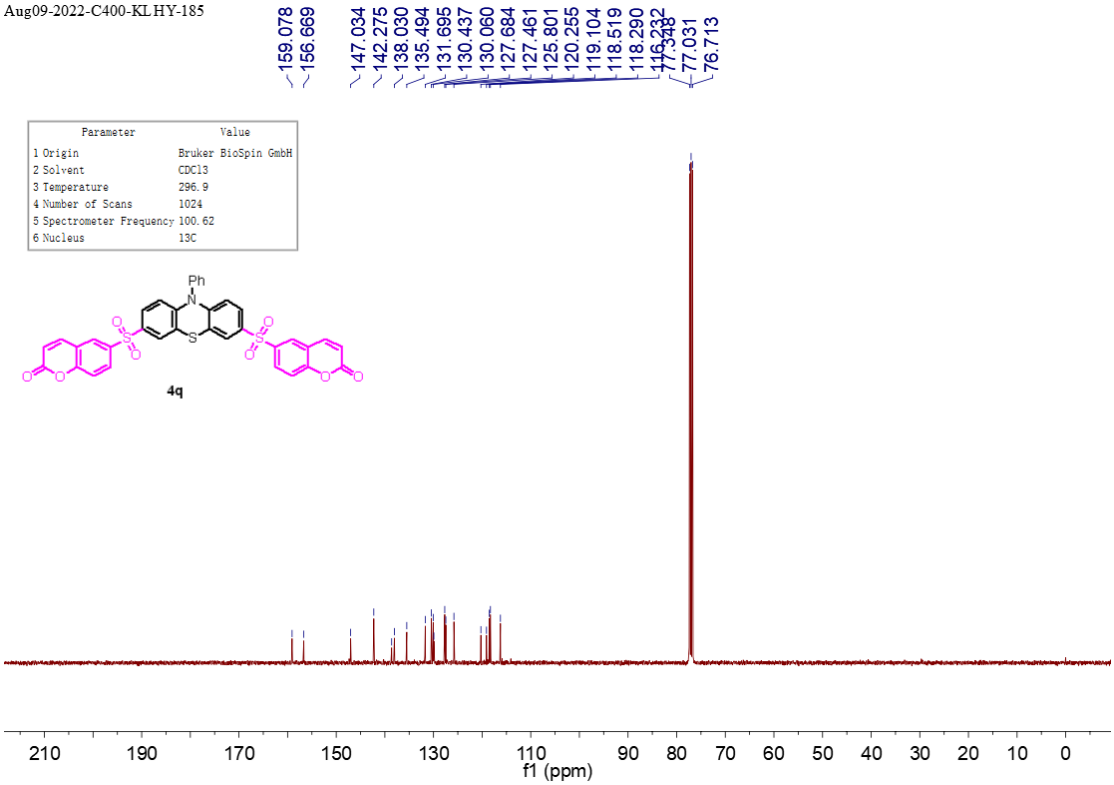
4q



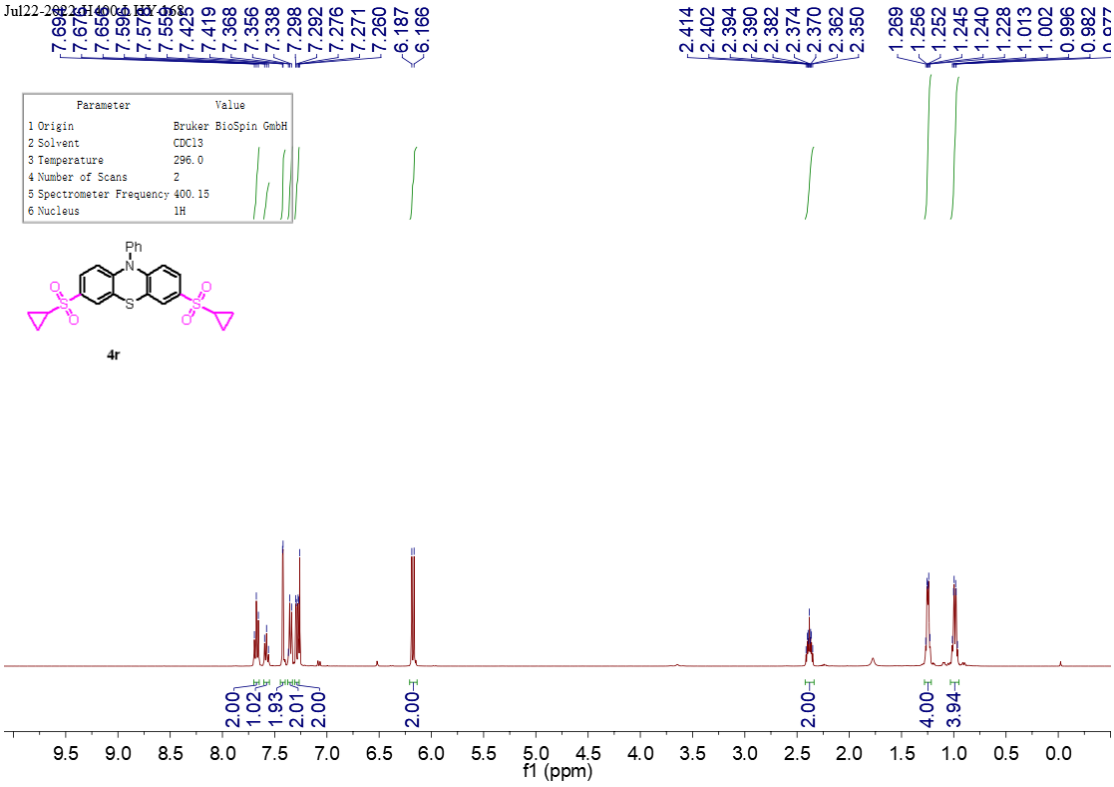
2.00
2.01
2.03
3.95
2.00
2.09
2.00
1.09
2.02
2.00

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)

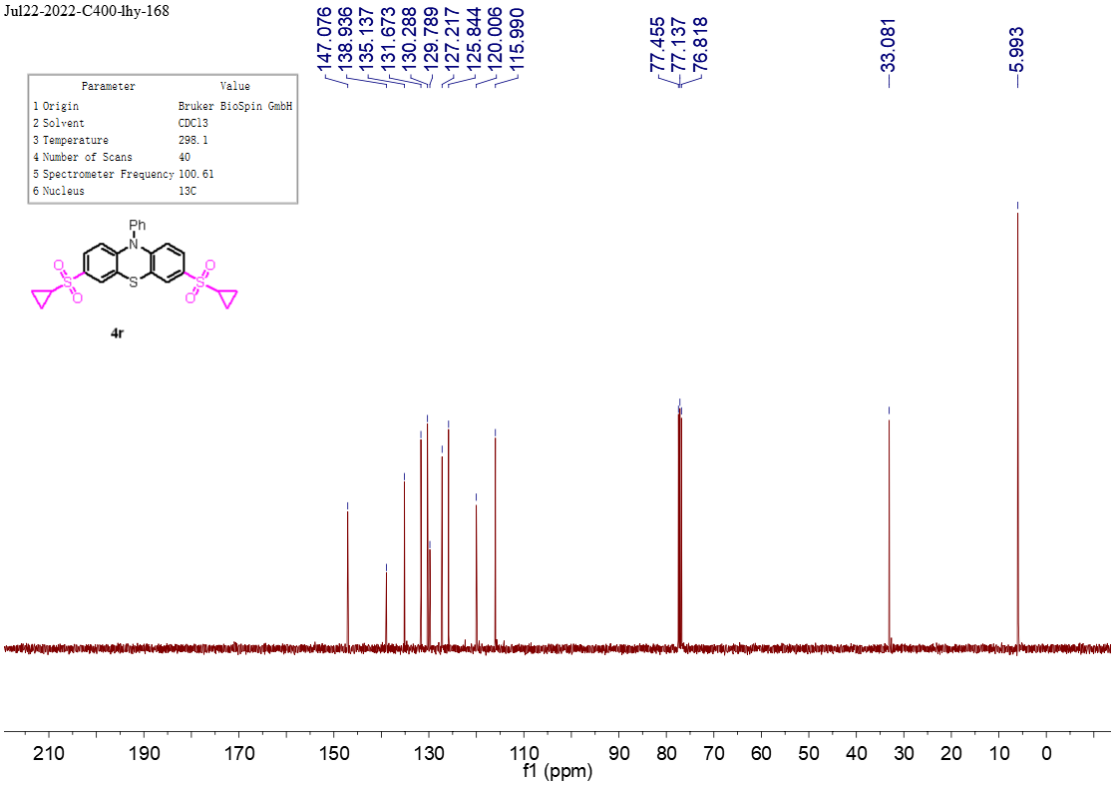
Aug09-2022-C400-KLHY-185



Jul22-2022-C400-KLHY-168

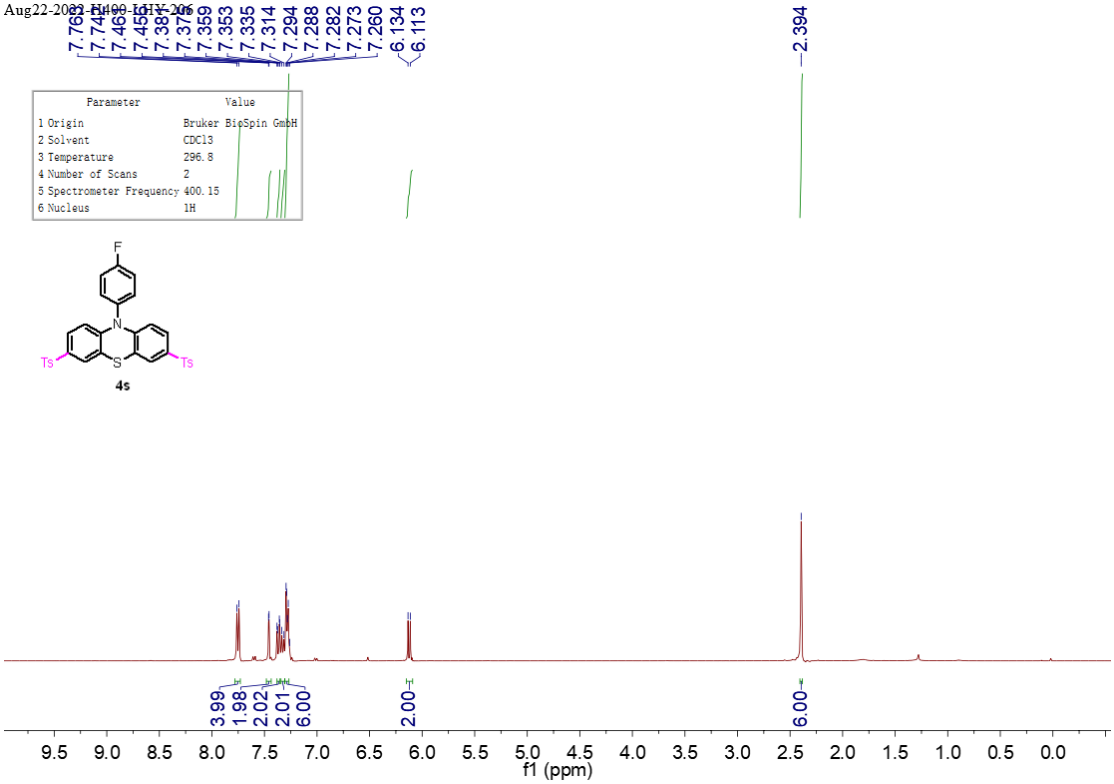


Jul22-2022-C400-lhy-168



4r

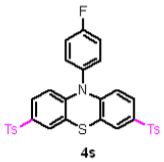
Aug22-2022-H400-lhy-206



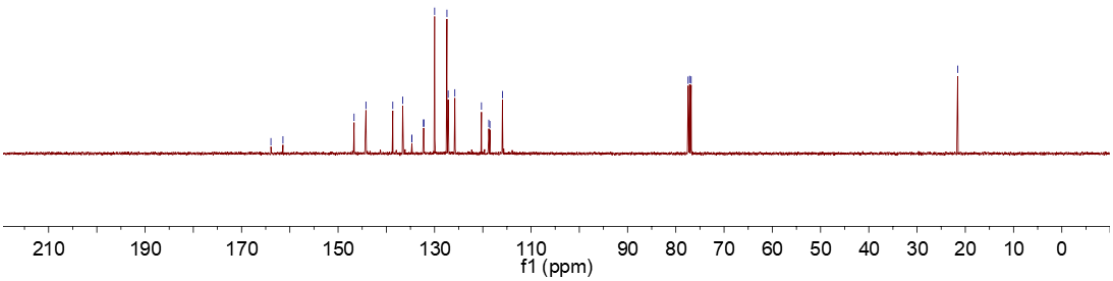
4s

Aug22-2022-h400-lhy-206

Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	298.1
4 Number of Scans	49
5 Spectrometer Frequency	100.61
6 Nucleus	13C

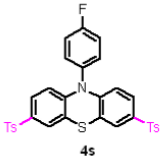


4s

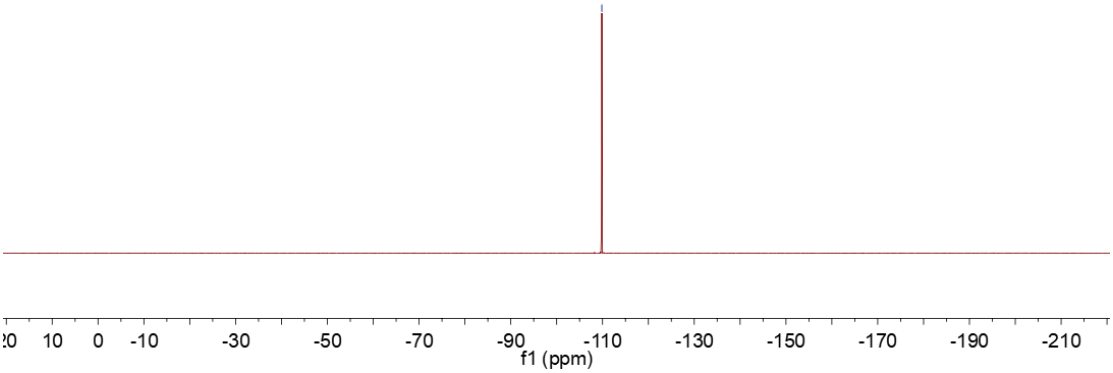


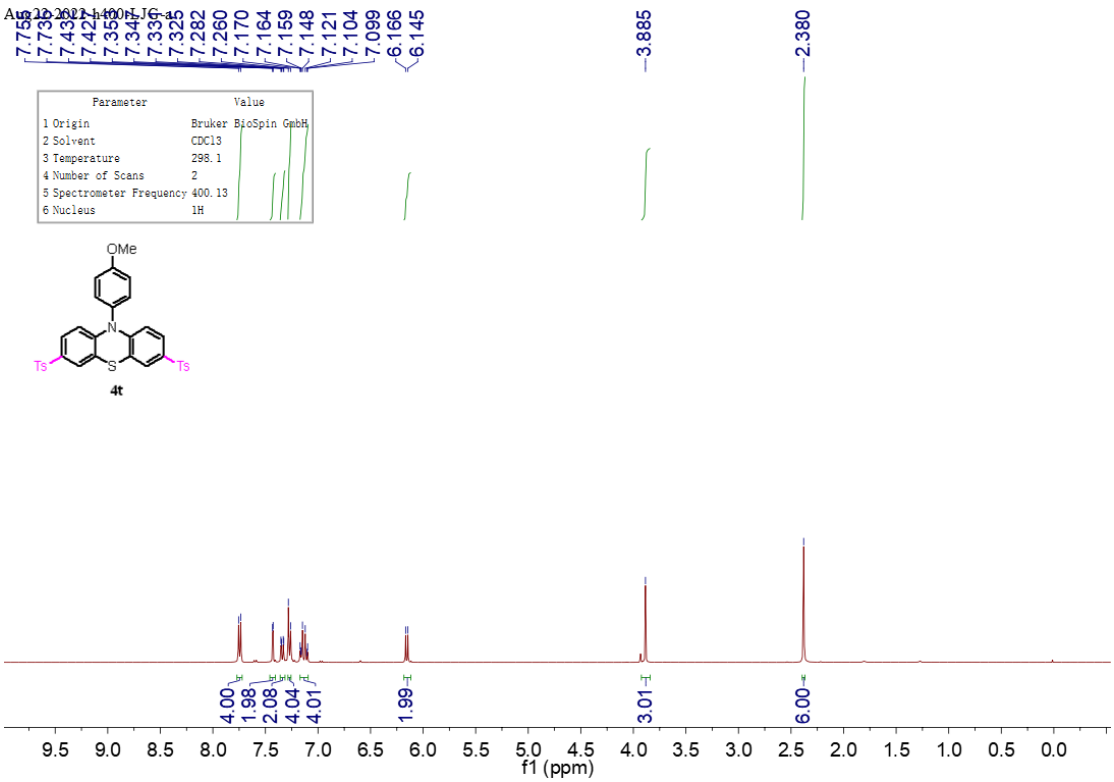
Aug24-2022-F400-LHY-206

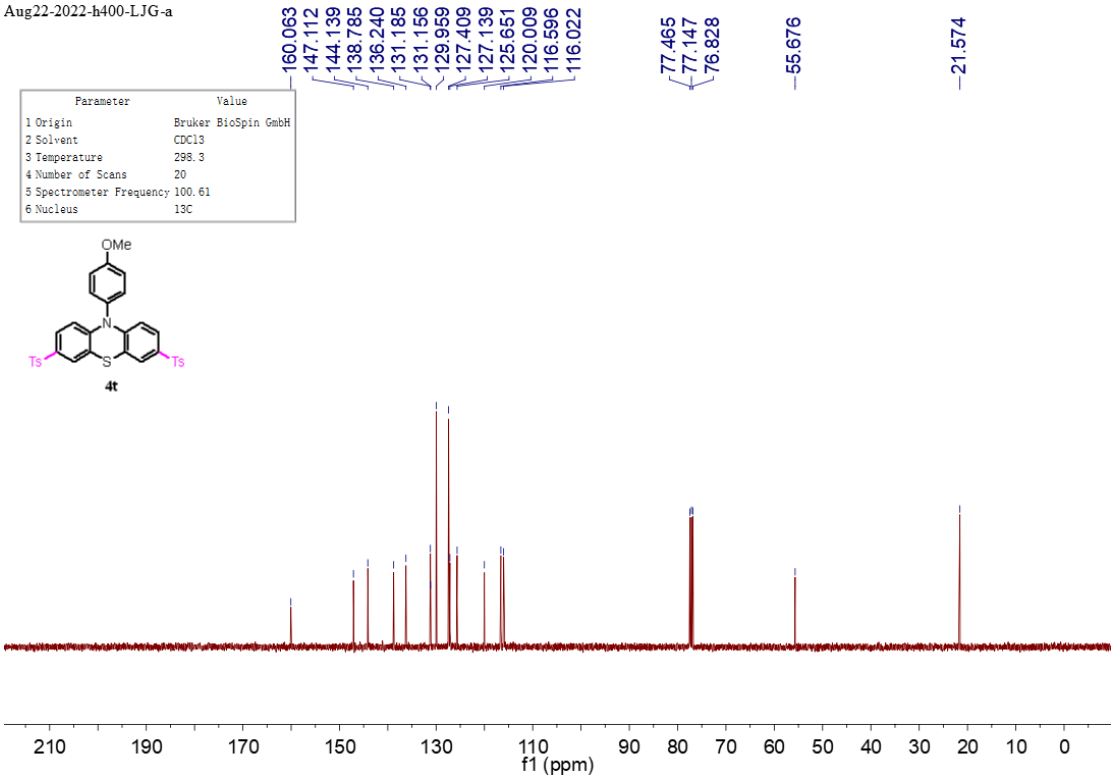
Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	297.2
4 Number of Scans	16
5 Spectrometer Frequency	376.52
6 Nucleus	19F

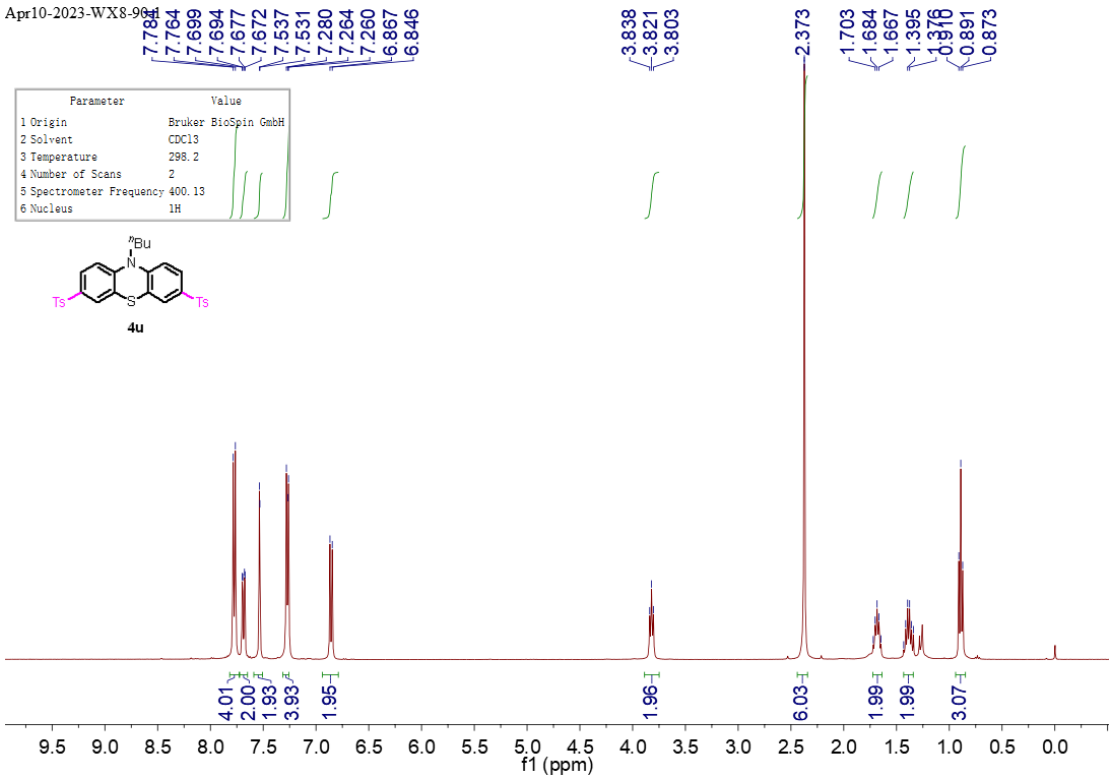


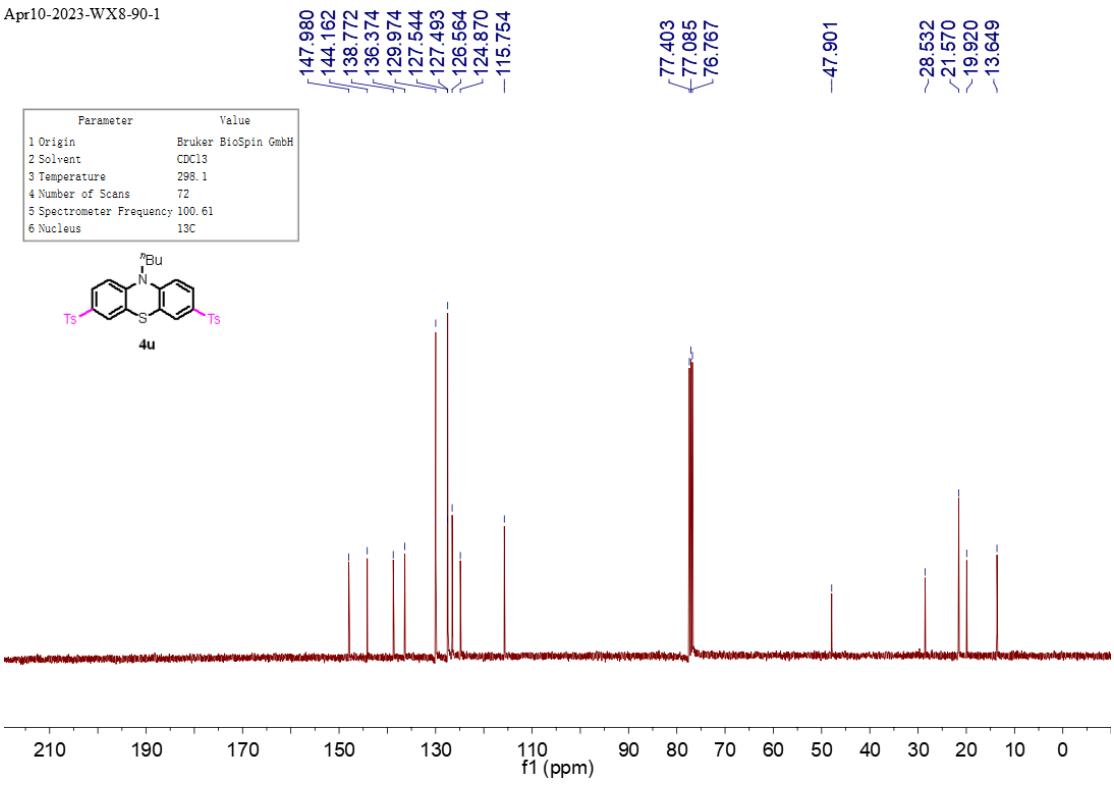
4s

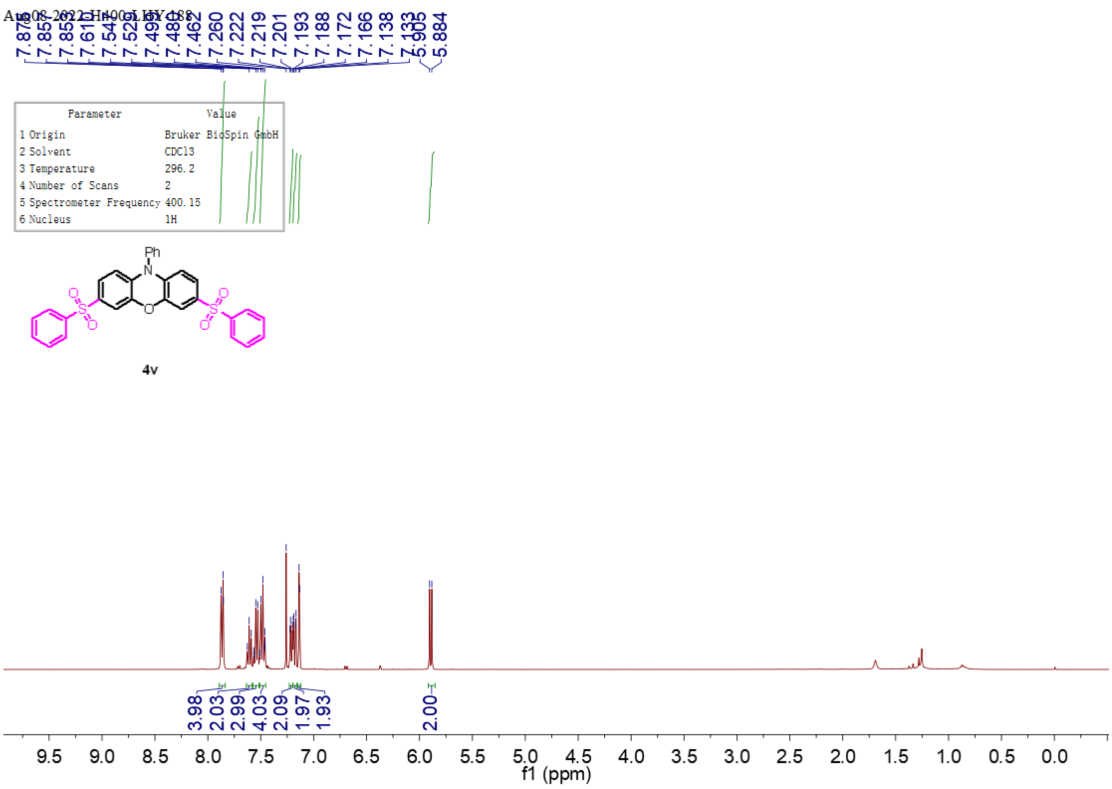



Aug22-2022-h400-LJG-a
7.755
7.738
7.431
7.427
7.353
7.347
7.335
7.325
7.282
7.260
7.170
7.164
7.159
7.148
7.121
7.104
7.099
6.166
6.145
3.885
2.380
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.1
4 Number of Scans 2
5 Spectrometer Frequency 400.13
6 Nucleus 1H
OMe
N
S
Ts
Ts
4t
4.00
1.98
2.08
4.04
4.01
1.99
3.01
6.00
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)

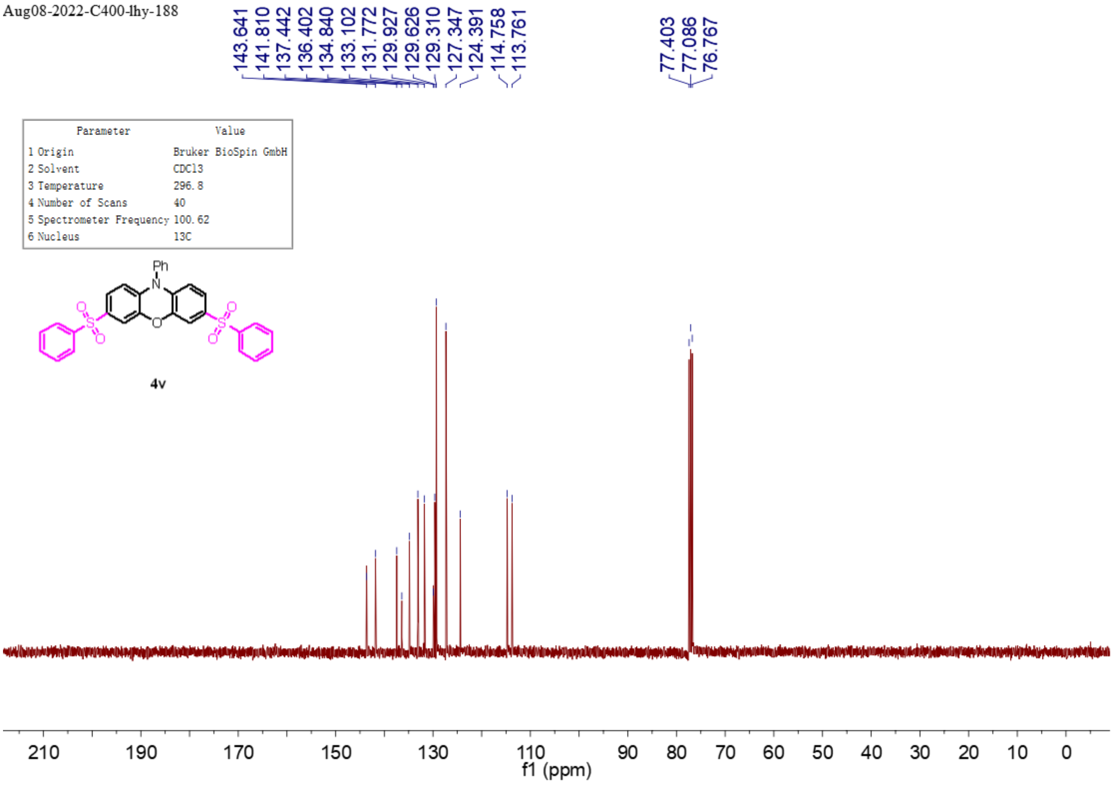

Aug22-2022-h400-LJG-a
160.063
147.112
144.139
138.785
136.240
131.185
131.156
129.959
127.409
127.139
125.651
120.009
116.596
116.022
77.465
77.147
76.828
55.676
21.574
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.3
4 Number of Scans 20
5 Spectrometer Frequency 100.61
6 Nucleus 13C
OMe
N
S
Ts
Ts
4t
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


Apr10-2023-WX8-90-1
7.784
7.764
7.699
7.694
7.677
7.672
7.537
7.531
7.280
7.264
7.260
6.867
6.846
3.838
3.821
3.803
2.373
1.703
1.684
1.667
1.395
1.376
0.910
0.891
0.873
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.2
4 Number of Scans 2
5 Spectrometer Frequency 400.13
6 Nucleus 1H
nBu
N
S
Ts
Ts
4u
4.01
2.00
1.93
3.93
1.95
1.96
6.03
1.99
1.99
3.07
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)

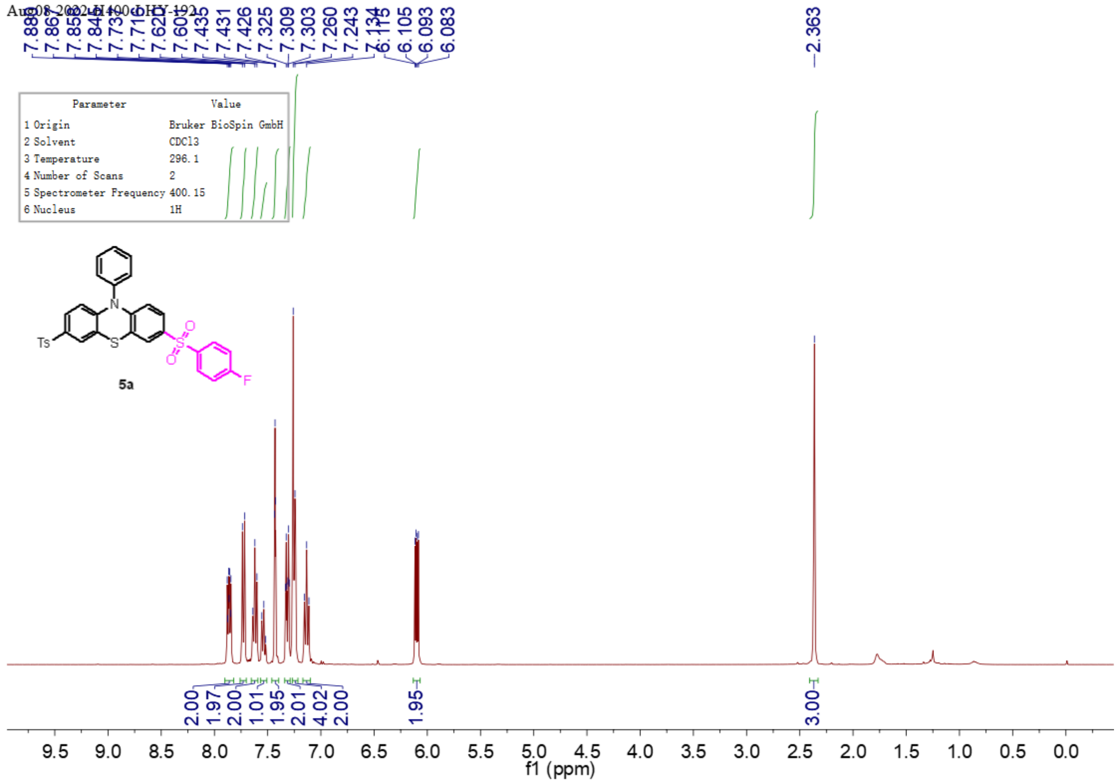

Apr10-2023-WX8-90-1
147.980
144.162
138.772
136.374
129.974
127.544
127.493
126.564
124.870
115.754
77.403
77.085
76.767
47.901
28.532
21.570
19.920
13.649
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 298.1
4 Number of Scans 72
5 Spectrometer Frequency 100.61
6 Nucleus 13C
nBu
N
S
Ts
Ts
4u
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

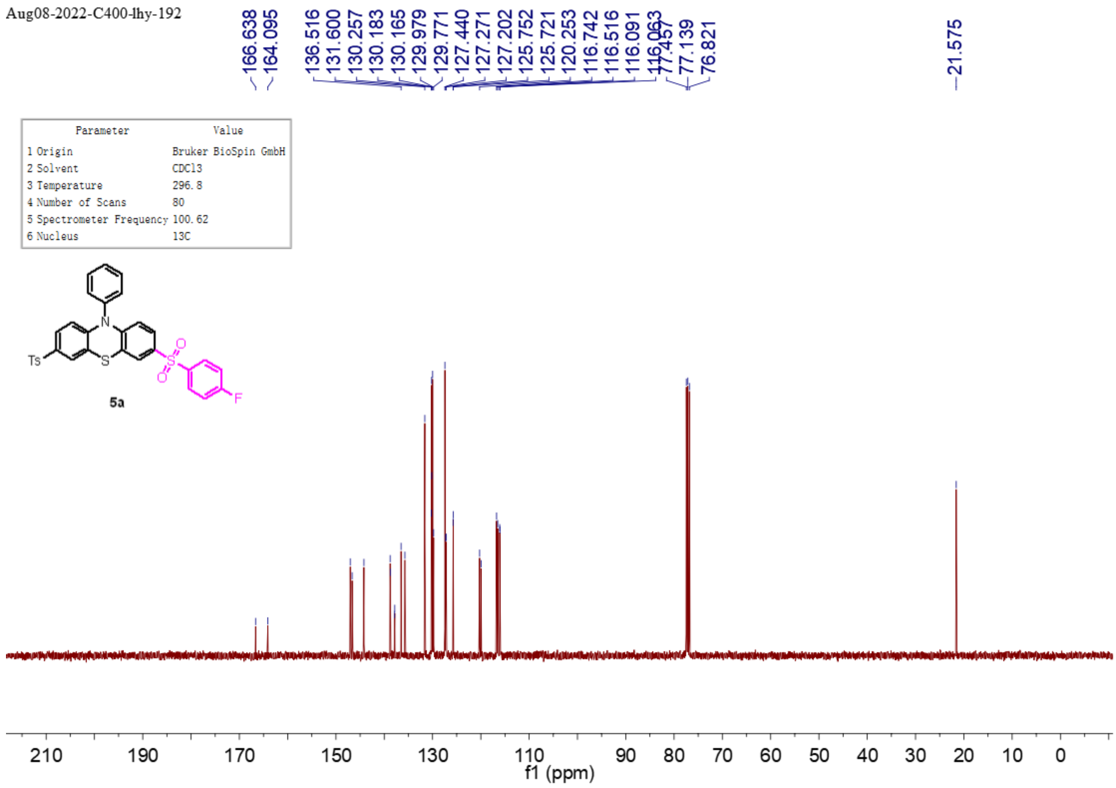


7.260
7.222
7.219
7.201
7.193
7.188
7.172
7.166
7.138
5.905
5.884
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 296.2
4 Number of Scans 2
5 Spectrometer Frequency 400.15
6 Nucleus 1H
Ph
N
O
4v
3.98
2.03
2.99
4.03
2.09
1.97
1.93
2.00
f1 (ppm)



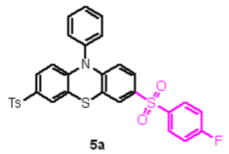
Aug08-2022-C400-lhy-188
143.641
141.810
137.442
136.402
134.840
133.102
131.772
129.927
129.626
129.310
127.347
124.391
114.758
113.761
77.403
77.086
76.767
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 296.8
4 Number of Scans 40
5 Spectrometer Frequency 100.62
6 Nucleus 13C
Ph
N
O
4v
f1 (ppm)


Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 296.1
4 Number of Scans 2
5 Spectrometer Frequency 400.15
6 Nucleus 1H
Ts
N
S
O
F
5a
2.363
2.00
1.97
2.00
1.01
1.95
2.01
4.02
2.00
1.95
3.00
f1 (ppm)


Aug08-2022-C400-lhy-192
166.638
164.095
136.516
131.600
130.257
130.183
130.165
129.979
129.771
127.440
127.271
127.202
125.752
125.721
120.253
116.742
116.516
116.091
116.063
77.457
77.139
76.821
21.575
Parameter Value
1 Origin Bruker BioSpin GmbH
2 Solvent CDCl3
3 Temperature 296.8
4 Number of Scans 80
5 Spectrometer Frequency 100.62
6 Nucleus 13C
Ts
N
S
O
F
5a
f1 (ppm)

Aug08-2022-F400-LHY-192

Parameter	Value
1 Origin	Bruker BioSpin GmbH
2 Solvent	CDCl3
3 Temperature	296.2
4 Number of Scans	2
5 Spectrometer Frequency	376.52
6 Nucleus	19F



5a