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Supporting Information

Asymmetric Construction of Enantioenriched Spiro *gem*-Diamines via [3+3] Annulation of α,β-Unsaturated *N*-Sulfonyl Ketimines and 3-Aminobenzofurans

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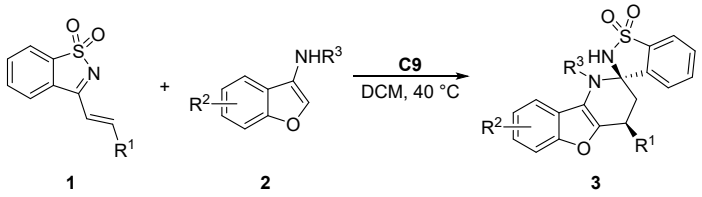
Content

1. General methods

Unless otherwise mentioned, all reagents were purchased from commercial suppliers without further purification. Solvent purification was conducted according to Purification of Laboratory Chemicals (Peerrin, D. D.; Armarego, W. L. and Perrins, D. R., Pergamon Press: Oxford, 1980). Reactions were monitored using Merck Kieselgel $60F_{254}$ aluminium plates. TLC was visualized by UV fluorescence (254 nm) then one of the following: $KMnO_4$, phosphomolybdic acid, ninhydrin, *p*-anisaldehyde, vanillin. If not specially mentioned, flash column chromatography was performed using Yantai xinnuo Chemicals (China) (particle size 0.040–0.063 mm). NMR spectra were recorded on JEOL 400 instruments or Bruker Avance NEO 400 and calibrated by using residual undeuterated chloroform-d (δ ^{1}H = 7.26 ppm, δ ^{13}C = 77.0 ppm) and DMSO-d_6 (δ ^{1}H = 2.50 ppm, δ ^{13}C = 40.0 ppm) as internal references. The following abbreviations were used to explain the multiplicities: s = singlet, d = doublet, t = triplet, q = quartet, b = broad, td = triple doublet, dt = double triplet, dq = double quartet, m = multiplet. Infrared (IR) spectra were recorded on an iCAN 9-T FT-IR spectrometer. High-resolution mass spectra (HRMS) were recorded on a Thermo Fisher Q Exactive Orbitrap mass spectrometer using ESI (electrosprayionization) as ionization method. α, β-Unsaturated cyclic *N*-sulfonyl ketimines **1**[1] and 3- aminobenzofurans **2**[2] are known compounds, which were synthesized according to the literature methods.

2. Experimental procedures and characterization data

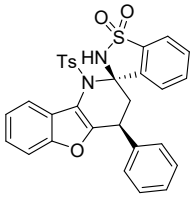
2.1 Synthesis of 3



1 2 3

Typical Procedure: α, β-Unsaturated cyclic *N*-sulfonyl ketimine **1** (0.12 mmol, 1.2 equiv), 3-aminobenzofuran **2** (0.10 mmol, 1.0 equiv) and **C9** (10 mol%) were added to the reaction flask. Then anhydrous dichloromethane (2 mL) was added. The resulting mixture was stirred at 40 °C. After completion of the reaction as monitored by TLC, the reaction mixture was directly charged to column chromatography on silica gel (eluent: dichloromethane) to give the product **3**.

(2*S*,4*S*)-4-phenyl-1-tosyl-3,4-dihydro-1*H*,2'*H*-spiro[benzofuro[3,2-*b*]pyridine-2,3'-benzo[*d*]isothiazole] 1',1'-dioxide (3aa)



Yellow foam, isolated yield: 97% (54 mg);

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.81-7.79 (m, 1H), 7.70-7.64 (m, 3H), 7.60 (d, J = 8.0 Hz, 2H), 7.32-7.21 (m, 6H), 7.18-7.08 (m, 4H), 7.05-7.01 (m, 1H), 6.57 (d, J = 4.7 Hz, 1H), 4.80 (dd, J = 9.1, 5.8 Hz, 1H), 3.80 (dd, J = 16.9, 9.1 Hz, 1H), 3.57 (dd, J = 16.9, 5.8 Hz, 1H), 2.28 (s, 3H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 173.0, 154.0, 153.2, 144.4, 140.3, 138.4, 135.4, 134.8, 133.3, 130.6, 129.7, 128.7, 127.9, 127.5, 127.4, 125.7, 124.6, 124.0, 123.1, 122.4, 120.1, 113.9, 111.2, 39.3, 35.6, 21.4;

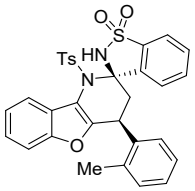
IR (neat): ν 3455, 2376, 1725, 1645, 1513, 1404, 1266, 1024, 804, 706 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{30}H_{25}N_2O_5S_2$: 557.1199; found: 557.1192;

$[\alpha]_D^{23}$ = -39.3 (c = 0.1, CH_2Cl_2);

The enantiomeric ratio of the product was determined by HPLC (Column Daicel Chiracel IC; ^{i}PrOH/Hexane = 50/50; flow rate = 1.0 mL/min; t_{R1} = 15.18 min, 96.5%; t_{R2} = 19.99 min, 3.5%).

(2*S*,4*S*)-4-(*o*-tolyl)-1-tosyl-3,4-dihydro-1*H*,2'*H*-spiro[benzofuro[3,2-*b*]pyridine-2,3'-benzo[*d*]isothiazole] 1',1'-dioxide (3ab)



Yellow solid, isolated yield: 93% (53 mg);

m.p.: 176.9-177.5 °C;

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.83-7.79 (m, 1H), 7.74-7.64 (m, 3H), 7.59 (d, J = 8.3 Hz, 2H), 7.52-7.49 (m, 1H), 7.35 (d, J = 8.3 Hz, 1H), 7.19-7.07 (m, 6H), 7.04-6.97 (m, 2H), 6.34 (s, 1H), 5.15 (dd, J = 8.3, 6.7 Hz, 1H), 3.78 (dd, J = 17.0, 8.2 Hz, 1H), 3.57 (dd, J = 17.0, 6.6 Hz, 1H), 2.33 (s, 3H), 2.26 (s, 3H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 173.9, 154.3, 153.5, 144.0, 139.3, 137.4, 136.3, 135.1, 133.9, 133.6, 130.9, 130.8, 129.6, 127.4, 127.35, 127.27, 126.5, 125.7, 124.5, 124.1, 123.1, 122.3, 119.3, 113.6, 111.2, 35.1 (2C), 21.4, 19.7;

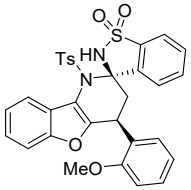
IR (neat): v 3463, 2302, 1609, 1320, 1166, 1037, 1013, 868, 811, 672 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{31}H_{27}N_2O_5S_2$: 571.1356; found: 571.1345;

$[\alpha]_D^{23}$ = -48.7 (c = 0.1, CH_2Cl_2);

The enantiomeric ratio of the product was determined by HPLC (Column Daicel Chiracel IC; ^{i}PrOH/Hexane = 50/50; flow rate = 1.0 mL/min; t_{R1} = 12.65 min, 5.0%; t_{R2} = 18.63 min, 95.0%).

(2*S*,4*S*)-4-(2-methoxyphenyl)-1-tosyl-3,4-dihydro-1*H*,2'*H*-spiro[benzofuro[3,2-*b*]pyridine-2,3'-benzo[*d*]isothiazole] 1',1'-dioxide (3ac)



Yellow solid, isolated yield: 96% (56 mg);

m.p.: 184.1-184.7 °C;

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.86-7.84 (m, 1H), 7.72-7.67 (m, 3H), 7.60 (d, J = 8.3 Hz, 2H), 7.51 (d, J = 9.3 Hz, 1H), 7.38 (d, J = 9.0 Hz, 1H), 7.24-7.16 (m, 4H), 7.08 (d, J = 8.0 Hz, 2H), 6.87-6.81 (m, 2H), 6.71 (s, 1H), 4.92 (dd, J = 8.4, 6.4 Hz, 1H), 3.83 (s, 3H), 3.73 (dd, J = 17.4, 8.3 Hz, 1H), 3.16 (dd, J = 17.4, 6.4 Hz, 1H), 2.07 (s, 3H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 173.5, 156.0, 153.4, 152.9, 143.7, 139.4, 135.7, 133.9, 133.5, 130.9, 129.6, 128.6, 127.4, 127.2, 127.0, 125.8, 124.5, 123.8, 123.3, 122.3, 121.1, 120.3, 114.0, 111.1, 111.0, 55.8, 33.5, 31.5, 21.2;

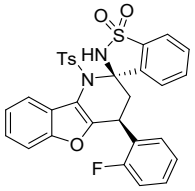
IR (neat): v 3641, 2347, 1704, 1654, 1514, 1402, 1281, 1019, 892, 754 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{31}H_{27}N_2O_6S_2$: 587.1305; found: 587.1299;

$[\alpha]_D^{23}$ = -98.7 (*c* = 0.1, CH_2Cl_2);

The enantiomeric ratio of the product was determined by HPLC (Column Daicel Chiracel IC; ^{i}PrOH/Hexane = 50/50; flow rate = 1.0 mL/min; t_{R1} = 15.96 min, 2.4%; t_{R2} = 22.72 min, 97.6%).

(2*S*,4*S*)-4-(2-fluorophenyl)-1-tosyl-3,4-dihydro-1*H*,2'*H*-spiro[benzofuro[3,2-*b*]pyridine-2,3'-benzo[*d*]isothiazole] 1',1'-dioxide (3ad)



Yellow foam, isolated yield: 97% (56 mg);

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.88-7.84 (m, 1H), 7.77-7.71 (m, 3H), 7.62 (d, *J* = 6.5 Hz, 2H), 7.37-7.35 (m, 2H), 7.29-7.22 (m, 3H), 7.144-7.01 (m, 5H), 6.57 (s, 1H), 5.06 (t, *J* = 7.3 Hz, 1H), 3.65 (d, *J* = 7.4 Hz, 2H), 2.20 (s, 3H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 173.4, 161.3 (d, *J* = 247.9 Hz), 153.3, 152.4, 142.3, 138.9, 136.1, 134.0, 133.8, 130.6, 129.6, 129.23 (d, *J* = 2.9 Hz), 129.16 (d, *J* = 2.0 Hz), 127.3, 125.83 (d, *J* = 7.1 Hz), 125.76 (d, *J* = 6.8 Hz), 124.8, 124.5 (d, *J* = 3.6 Hz), 124.0, 123.3, 122.4, 119.9, 115.8 (d, *J* = 22.4 Hz), 114.4, 111.8, 35.1, 32.8, 20.7;

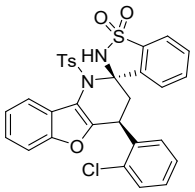
IR (neat): *v* 3649, 2352, 1610, 1533, 1457, 1342, 1136, 1095, 754, 660 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{30}H_{24}FN_2O_5S_2$: 575.1105; found: 575.1102;

$[\alpha]_D^{23}$ = -14.0 (*c* = 0.1, CH_2Cl_2);

The enantiomeric ratio of the product was determined by HPLC (Column Daicel Chiracel ID; ^{i}PrOH/Hexane = 50/50; flow rate = 1.0 mL/min; t_{R1} = 22.90 min, 97.7%; t_{R2} = 31.82 min, 2.3%).

(2*S*,4*S*)-4-(2-chlorophenyl)-1-tosyl-3,4-dihydro-1*H*,2'*H*-spiro[benzofuro[3,2-*b*]pyridine-2,3'-benzo[*d*]isothiazole] 1',1'-dioxide (3ae)



Yellow solid, isolated yield: 99% (58 mg);

m.p.: 182.6-183.4 °C;

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.83-7.79 (m, 1H), 7.72-7.67 (m, 3H), 7.57-7.55 (m, 2H), 7.49-7.46 (m, 1H), 7.36-7.31 (m, 3H), 7.24-7.18 (m, 3H), 7.14-7.10 (m, 1H), 7.01-6.99 (m, 2H), 5.18 (dd, J = 8.2, 6.3 Hz, 1H), 3.64 (dd, J = 17.8, 6.4 Hz, 1H), 3.55 (dd, J = 17.8, 8.3 Hz, 1H), 2.12 (s, 3H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 173.3, 153.4, 152.2, 143.7, 139.3, 136.4, 135.9, 134.0, 133.7, 133.2, 130.5, 129.8, 129.6, 128.8, 128.7, 127.3, 127.2, 125.8, 124.8, 124.0, 123.3, 122.3, 120.1, 114.2, 111.1, 36.8, 34.4, 21.7;

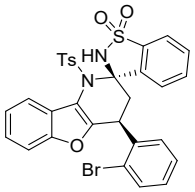
IR (neat): v 3521, 2680, 2342, 1335, 1173, 1047, 1027, 802, 761, 657 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{30}H_{24}ClN_2O_5S_2$: 591.0810; found: 591.0797;

$[\alpha]_D^{23}$ = -78.7 (c = 0.1, CH_2Cl_2);

The enantiomeric ratio of the product was determined by HPLC (Column Daicel Chiracel ID; ^{i}PrOH/Hexane = 50/50; flow rate = 1.0 mL/min; t_{R1} = 22.46 min, 98.4%; t_{R2} = 32.85 min, 1.6%).

(2*S*,4*S*)-4-(2-bromophenyl)-1-tosyl-3,4-dihydro-1*H*,2'*H*-spiro[benzofuro[3,2-*b*]pyridine-2,3'-benzo[*d*]isothiazole] 1',1'-dioxide (3af)



Yellow solid, isolated yield: 99% (63 mg);

m.p.: 126.8-127.3 °C;

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.83-7.81 (m, 1H), 7.72-7.68 (m, 3H), 7.58 (d, J = 8.4 Hz, 2H), 7.52-7.48 (m, 2H), 7.36 (d, J = 8.1 Hz, 2H), 7.25-7.20 (m, 2H), 7.15-7.09 (m, 2H), 7.02 (d, J = 8.1 Hz, 2H), 6.54 (s, 1H), 5.16 (dd, J = 8.2, 6.3 Hz, 1H), 3.65 (dd, J = 17.8, 6.4 Hz, 1H), 3.50 (dd, J = 17.8, 8.2 Hz, 1H), 2.11 (s, 3H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 173.5, 153.4, 152.1, 144.2, 139.4, 138.0, 135.9, 134.5, 133.7, 133.2, 130.5, 129.6, 129.0, 128.9, 128.3, 127.2, 125.8, 124.8, 124.01, 123.99, 123.4, 122.7, 120.2, 115.1, 111.2, 38.4, 34.6, 20.4;

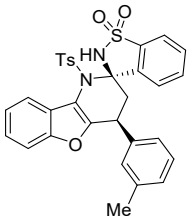
IR (neat): v 3562, 2326, 1454, 1342, 1177, 1094, 1026, 911, 804, 779 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{30}H_{24}BrN_2O_5S_2$: 635.0305; found: 635.0288;

$[\alpha]_D^{23}$ = -29.3 (c = 0.1, CH_2Cl_2);

The enantiomeric ratio of the product was determined by HPLC (Column Daicel Chiracel ID; ^{i}PrOH/Hexane = 50/50; flow rate = 1.0 mL/min; t_{R1} = 26.33 min, 99.9%; t_{R2} = 42.18 min, 0.1%).

(2*S*,4*S*)-4-(*m*-tolyl)-1-tosyl-3,4-dihydro-1*H*,2'*H*-spiro[benzofuro[3,2-*b*]pyridine-2,3'-benzo[*d*]isothiazole] 1',1'-dioxide (3ag)



Yellow solid, isolated yield: 91% (52 mg);

m.p.: 123.1-123.9 °C;

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.83-7.81 (m, 1H), 7.70-7.65 (m, 3H), 7.63-7.60 (m, 2H), 7.33 (d, J = 8.3 Hz, 1H), 7.19-7.09 (m, 6H), 7.06-7.03 (m, 3H), 6.51 (s, 1H), 4.76 (dd, J = 9.1, 5.8 Hz, 1H), 3.79 (dd, J = 16.7, 9.1 Hz, 1H), 3.56 (dd, J = 16.7, 5.8 Hz, 1H), 2.32 (s, 3H), 2.29 (s, 3H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 174.1, 153.7, 153.2, 143.9, 139.2, 138.7, 138.4, 136.4, 133.9, 133.7, 130.7, 129.7, 128.62, 128.57, 128.3, 127.4, 125.8, 124.9, 124.5, 124.0, 123.1, 122.4, 119.6, 113.9, 111.6, 38.8, 35.6, 21.42, 21.40;

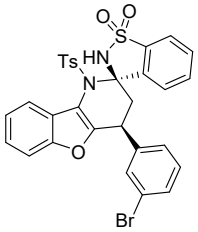
IR (neat): v 3433, 2367, 1710, 1567, 1455, 1340, 1169, 1037, 898, 718 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{31}H_{27}N_2O_5S_2$: 571.1356; found: 571.1354;

$[\alpha]_D^{23}$ = -110.7 (c = 0.1, CH_2Cl_2);

The enantiomeric ratio of the product was determined by HPLC (Column Daicel Chiracel IC; ^{i}PrOH/Hexane = 50/50; flow rate = 1.0 mL/min; t_{R1} = 14.26 min, 96.0%; t_{R2} = 20.63 min, 4.0%).

(2*S*,4*S*)-4-(3-bromophenyl)-1-tosyl-3,4-dihydro-1*H*,2'*H*-spiro[benzofuro[3,2-*b*]pyridine-2,3'-benzo[*d*]isothiazole] 1',1'-dioxide (3ah)



Yellow foam, isolated yield: 95% (60 mg);

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.87-7.85 (m, 1H), 7.74-7.67 (m, 3H), 7.62 (d, J = 8.3 Hz, 2H), 7.47-7.46 (m, 1H), 7.41-7.38 (m, 1H), 7.35 (d, J = 8.3 Hz, 1H), 7.25-7.17 (m, 3H), 7.15-7.12 (m, 2H), 7.06 (d, J = 4.2 Hz, 2H), 6.48 (s, 1H), 4.84 (dd, J = 9.6, 5.2 Hz, 1H), 3.84 (dd, J = 17.0, 9.6 Hz, 1H), 3.54 (dd, J = 17.0, 5.3 Hz, 1H), 2.30 (s, 3H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 173.6, 153.3, 152.8, 143.5, 140.4, 139.3, 136.4, 134.4, 134.0, 130.9, 130.7, 130.6, 130.3, 129.7, 127.4, 126.8, 125.6, 124.8, 124.0, 123.3, 122.8, 122.6, 120.7, 115.0, 112.0, 38.9, 35.2, 22.2;

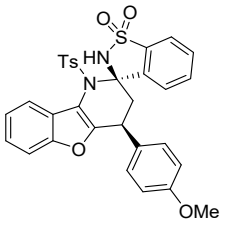
IR (neat): v 3547, 2365, 1743, 1605, 1462, 1340, 1128, 1042, 847, 783 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{30}H_{24}BrN_2O_5S_2$: 635.0305; found: 635.0298;

$[\alpha]_D^{23}$ = -84.0 (*c* = 0.1, CH_2Cl_2);

The enantiomeric ratio of the product was determined by HPLC (Column Daicel Chiracel IC; ^{i}PrOH/Hexane = 50/50; flow rate = 1.0 mL/min; t_{R1} = 12.29 min, 97.0%; t_{R2} = 17.69 min, 3.0%).

(2*S*,4*S*)-4-(4-methoxyphenyl)-1-tosyl-3,4-dihydro-1*H*,2'*H*-spiro[benzofuro[3,2-*b*]pyridine-2,3'-benzo[*d*]isothiazole] 1',1'-dioxide (3ai)



Yellow foam, isolated yield: 94% (55 mg);

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.84-7.82 (m, 1H), 7.70-7.65 (m, 3H), 7.61 (d, *J* = 8.4 Hz, 2H), 7.32 (d, *J* = 8.3 Hz, 1H), 7.21-7.12 (m, 5H), 7.08-7.01 (m, 2H), 6.83-6.80 (m, 2H), 6.47 (s, 1H), 4.76 (dd, *J* = 9.0, 5.8 Hz, 1H), 3.77-3.71 (m, 4H), 3.54 (dd, *J* = 16.7, 5.9 Hz, 1H), 2.30 (s, 3H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 173.4, 160.5, 154.9, 153.1, 145.2, 139.9, 136.4, 134.5, 133.7, 130.8, 130.7, 129.7, 129.0, 127.4, 125.7, 124.5, 124.0, 123.1, 122.4, 120.0, 114.1, 113.6, 112.0, 55.2, 38.6, 35.7, 22.1;

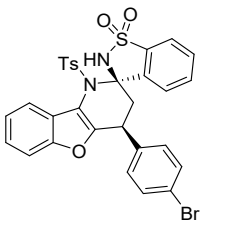
IR (neat): *v* 3498, 2353, 1610, 1515, 1459, 1339, 1093, 1040, 831, 748 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{31}H_{27}N_2O_6S_2$: 587.1305; found: 587.1302;

$[\alpha]_D^{23}$ = -71.3 (*c* = 0.1, CH_2Cl_2);

The enantiomeric ratio of the product was determined by HPLC (Column Daicel Chiracel AD; ^{i}PrOH/Hexane = 50/50; flow rate = 1.0 mL/min; t_{R1} = 18.93 min, 93.0%; t_{R2} = 22.50 min, 7.0%).

(2*S*,4*S*)-4-(4-bromophenyl)-1-tosyl-3,4-dihydro-1*H*,2'*H*-spiro[benzofuro[3,2-*b*]pyridine-2,3'-benzo[*d*]isothiazole] 1',1'-dioxide (3aj)



Yellow foam, isolated yield: 95% (60 mg);

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.85-7.83 (m, 1H), 7.72-7.67 (m, 3H), 7.59-7.57 (m, 2H), 7.41-7.39 (m, 2H), 7.33 (d, *J* = 8.3 Hz, 1H), 7.20-7.16 (m, 3H), 7.11 (d, *J* = 8.1 Hz, 2H), 7.06-7.02 (m, 2H), 6.59 (d, *J*

= 5.0 Hz, 1H), 4.85 (dd, *J* = 9.1, 5.7 Hz, 1H), 3.81 (dd, *J* = 17.0, 9.1 Hz, 1H), 3.55 (dd, *J* = 17.0, 5.8 Hz, 1H), 2.29 (s, 3H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 173.7, 153.2, 153.1, 143.6, 139.2, 137.9, 136.3, 134.0, 133.9, 131.8, 130.6, 129.73, 129.67, 127.4, 125.6, 124.8, 124.0, 123.3, 122.5, 121.5, 119.7, 114.2, 111.2, 38.2, 35.4, 21.4;

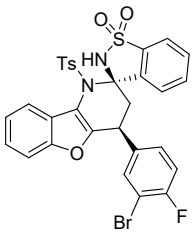
IR (neat): *v* 3231, 2342, 1712, 1556, 1341, 1265, 1098, 1022, 807, 676 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{30}H_{24}BrN_2O_5S_2$: 635.0305; found: 635.0300;

$[\alpha]_D^{23}$ = -94.7 (*c* = 0.1, CH_2Cl_2);

The enantiomeric ratio of the product was determined by HPLC (Column Daicel Chiracel IC; ^{i}PrOH/Hexane = 50/50; flow rate = 1.0 mL/min; t_{R1} = 12.19 min, 95.1%; t_{R2} = 16.49 min, 4.9%).

(2*S*,4*S*)-4-(3-bromo-4-fluorophenyl)-1-tosyl-3,4-dihydro-1*H*,2'*H*-spiro[benzofuro[3,2-*b*]pyridine-2,3'-benzo[*d*]isothiazole] 1',1'-dioxide (3ak)



Yellow foam, isolated yield: 91% (59 mg);

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.85-7.82 (m, 1H), 7.73-7.67 (m, 3H), 7.60 (d, *J* =8.2 Hz, 2H), 7.55 (dd, *J* = 6.4, 2.3 Hz, 1H), 7.34 (d, *J* =8.3 Hz, 1H), 7.29-7.27 (m, 1H), 7.21-7.16 (m, 1H), 7.12 (d, *J* =8.1 Hz, 2H), 7.06-7.00 (m, 3H), 6.68 (s, 1H), 4.90 (dd, *J* = 9.0, 5.8 Hz, 1H), 3.80 (dd, *J* = 17.1, 9.1 Hz, 1H), 3.56 (dd, *J* = 17.1, 5.8 Hz, 1H), 2.28 (s, 3H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 173.6, 159.5 (d, *J* = 248.7 Hz), 153.2, 152.7, 144.0, 139.1, 136.34 (d, *J* = 3.7 Hz), 136.26, 134.1, 133.9, 132.9, 130.5, 129.6, 128.9 (d, *J* = 7.4 Hz), 127.4, 125.4, 124.8, 124.0, 123.3, 122.5, 119.7, 116.6 (d, *J* = 22.4 Hz), 114.3, 111.2, 109.2 (d, *J* = 21.2 Hz), 37.7, 35.6, 21.4;

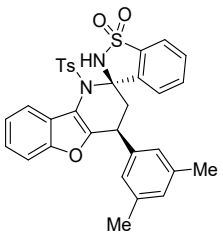
IR (neat): *v* 3622, 2345, 1742, 1497, 1459, 1342, 1174, 1021, 802, 754 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{30}H_{23}BrFN_2O_5S_2$: 653.0210; found: 653.0207;

$[\alpha]_D^{23}$ = -71.3 (*c* = 0.1, CH_2Cl_2);

The enantiomeric ratio of the product was determined by HPLC (Column Daicel Chiracel IC; ^{i}PrOH/Hexane = 50/50; flow rate = 1.0 mL/min; t_{R1} = 9.51 min, 90.5%; t_{R2} = 13.21 min, 9.5%).

(2*S*,4*S*)-4-(3,5-dimethylphenyl)-1-tosyl-3,4-dihydro-1*H*,2'*H*-spiro[benzofuro[3,2-*b*]pyridine-2,3'-benzo[*d*]isothiazole] 1',1'-dioxide (3al)



Yellow solid, isolated yield: 98% (57 mg);

m.p.: 133.0-133.7 °C;

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.84-7.82 (m, 1H), 7.70-7.63 (m, 5H), 7.34 (d, J = 8.2 Hz, 1H), 7.20-7.11 (m, 4H), 7.07-7.03 (m, 1H), 6.87 (s, 3H), 6.43 (s, 1H), 4.71 (dd, J = 9.2, 5.6 Hz, 1H), 3.78 (dd, J = 16.7, 9.3 Hz, 1H), 3.53 (dd, J = 16.7, 5.7 Hz, 1H), 2.30 (s, 3H), 2.28 (s, 6H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 174.1, 153.7, 153.1, 143.9, 139.2, 138.7, 138.3, 136.4, 133.9, 133.7, 130.7, 129.6, 129.2, 127.4, 125.9, 125.6, 124.5, 124.0, 123.1, 122.4, 119.6, 113.9, 111.2, 38.9, 35.6, 21.4, 21.3;

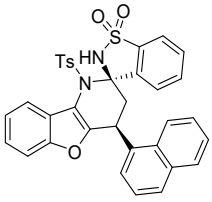
IR (neat): v 3338, 2343, 1666, 1452, 1342, 1174, 1097, 1015, 844, 667 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{32}H_{29}N_2O_5S_2$: 585.1512; found: 585.1511;

$[\alpha]_D^{23}$ = -146.7 (c = 0.1, CH_2Cl_2);

The enantiomeric ratio of the product was determined by HPLC (Column Daicel Chiracel IC; ^{i}PrOH/Hexane = 50/50; flow rate = 1.0 mL/min; t_{R1} = 12.72 min, 97.2%; t_{R2} = 23.96 min, 2.8%).

(2*S*,4*S*)-4-(naphthalen-1-yl)-1-tosyl-3,4-dihydro-1*H*,2'*H*-spiro[benzofuro[3,2-*b*]pyridine-2,3'-benzo[*d*]isothiazole] 1',1'-dioxide (3am)



White solid, isolated yield: 91% (55 mg);

m.p.: 187.2-188.0 °C;

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.94-7.87 (m, 2H), 7.81-7.77 (m, 2H), 7.66-7.51 (m, 6H), 7.44-7.33 (m, 5H), 7.23-7.20 (m, 1H), 7.14-7.10 (m, 1H), 6.70 (d, J = 8.2 Hz, 2H), 6.48 (s, 1H), 5.57 (dd, J = 9.9, 4.4 Hz, 1H), 3.97 (dd, J = 17.7, 9.9 Hz, 1H), 3.60 (dd, J = 17.7, 4.4 Hz, 1H), 1.98 (s, 3H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 174.2, 153.3, 153.0, 143.5, 139.3, 135.9, 135.1, 133.9 (2C), 133.7, 130.6, 130.3, 129.3, 129.2, 128.2, 127.0, 126.9, 126.1, 125.9, 125.4, 125.3, 124.6, 124.0, 123.3, 122.5, 122.4, 120.1, 114.8, 111.1, 35.5, 34.5, 21.2;

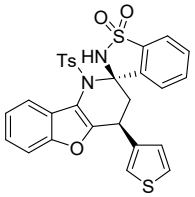
IR (neat): v 3692, 2226, 1649, 1467, 1348, 1266, 1175, 1089, 1041, 816 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{34}H_{27}N_2O_5S_2$: 607.1356; found: 607.1347;

$[\alpha]_D^{23}$ = -35.7 (*c* = 0.1, CH_2Cl_2);

The enantiomeric ratio of the product was determined by HPLC (Column Daicel Chiracel AD; ^{i}PrOH/Hexane = 50/50; flow rate = 1.0 mL/min; t_{R1} = 8.60 min, 95.5%; t_{R2} = 18.40 min, 4.5%).

(2*S*,4*S*)-4-(thiophen-3-yl)-1-tosyl-3,4-dihydro-1*H*,2'*H*-spiro[benzofuro[3,2-*b*]pyridine-2,3'-benzo[*d*]isothiazole] 1',1'-dioxide (3an)



Yellow foam, isolated yield: 93% (52 mg);

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.83-7.81 (m, 1H), 7.68-7.66 (m, 3H), 7.60 (d, *J* = 6.4 Hz, 2H), 7.33(d, *J* = 8.3 Hz, 1H), 7.24-7.00 (m, 8H), 6.69 (s, 1H), 4.89 (dd, *J* = 9.0, 6.0 Hz, 1H), 3.70 (dd, *J* = 16.8, 8.9 Hz, 1H), 3.57 (dd, *J* = 16.8, 5.9 Hz, 1H), 2.28 (s, 3H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 173.9, 153.24, 153.18, 143.9, 139.2, 138.8, 136.4, 134.0, 133.8, 130.6, 129.6, 127.4, 127.2, 126.0, 125.7, 124.7, 124.0, 123.2, 122.5, 122.4, 119.8, 113.9, 111.2, 35.8, 34.5, 21.4;

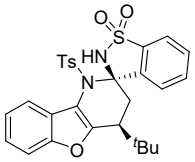
IR (neat): *v* 3444, 2342, 1651, 1342, 1173, 1086, 856, 809, 775, 675 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{28}H_{23}N_2O_5S_3$: 563.0764; found: 563.0762;

$[\alpha]_D^{23}$ = -79.3 (*c* = 0.1, CH_2Cl_2);

The enantiomeric ratio of the product was determined by HPLC (Column Daicel Chiracel IC; ^{i}PrOH/Hexane = 50/50; flow rate = 1.0 mL/min; t_{R1} = 15.05 min, 91.9%; t_{R2} = 25.13 min, 8.1%).

(2*S*,4*S*)-4-(*tert*-butyl)-1-tosyl-3,4-dihydro-1*H*,2'*H*-spiro[benzofuro[3,2-*b*]pyridine-2,3'-benzo[*d*]isothiazole] 1',1'-dioxide (3ao)



Yellow foam, isolated yield: 82% (44 mg);

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.83-7.80 (m, 1H), 7.67-7.64 (m, 5H), 7.32 (d, *J* = 8.3 Hz, 1H), 7.20 (d, *J* = 8.0 Hz, 2H), 7.16-7.12 (m, 1H), 6.98-6.95 (m, 1H), 6.85 (d, *J* = 9.7 Hz, 1H), 6.58 (s, 1H), 3.50 (dd, *J* = 8.8, 5.4 Hz, 1H), 3.38-3.29 (m, 2H), 2.37 (s, 3H), 1.04 (s, 9H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 175.8, 154.9, 152.9, 143.7, 139.0, 137.9, 134.3, 133.7, 130.7, 129.6, 127.5, 125.3, 124.3, 123.9, 122.9, 122.4, 119.2, 115.6, 111.0, 43.2, 34.6, 30.9, 28.6, 21.4;

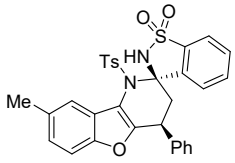
IR (neat): *v* 3241, 2415, 1661, 1456, 1329, 1165, 1041, 883, 728, 666 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{28}H_{29}N_2O_5S_3$: 537.1512; found: 537.1509;

$[\alpha]_D^{23}$ = 14.0 (*c* = 0.1, CH_2Cl_2);

The enantiomeric ratio of the product was determined by HPLC (Column Daicel Chiracel IC; ^{i}PrOH/Hexane = 30/70; flow rate = 1.0 mL/min; t_{R1} = 7.81 min, 90.4%; t_{R2} = 9.57 min, 9.6%).

(2*S*,4*S*)-8-methyl-4-phenyl-1-tosyl-3,4-dihydro-1*H*,2'*H*-spiro[benzofuro[3,2-*b*]pyridine-2,3'-benzo[*d*]isothiazole] 1',1'-dioxide (3ba)



Yellow solid, isolated yield: 90% (51 mg);

m.p.: 134.8-135.4 °C;

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.80-7.78 (m, 1H), 7.68-7.57 (m, 5H), 7.26-7.20 (m, 5H), 7.16 (d, *J* = 8.4 Hz, 1H), 7.10 (d, *J* = 8.1 Hz, 2H), 6.95 (dd, *J* = 8.5, 1.9 Hz, 1H), 6.69 (s, 1H), 6.42 (s, 1H), 4.77 (dd, *J* = 9.1, 5.7 Hz, 1H), 3.79 (dd, *J* = 16.7, 9.2 Hz, 1H), 3.54 (dd, *J* = 16.7, 5.8 Hz, 1H), 2.28 (s, 3H), 2.20 (s, 3H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 174.5, 153.8, 151.6, 143.9, 139.1, 138.8, 136.4, 134.0, 133.7, 132.6, 130.6, 129.6, 128.7, 127.9, 127.5, 127.4, 125.8, 125.7, 124.1, 122.4, 119.3, 113.6, 110.6, 38.9, 35.5, 21.4, 21.0;

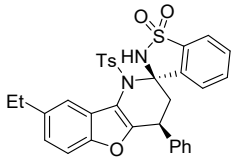
IR (neat): *v* 3591, 2365, 1609, 1457, 1338, 1168, 962, 908, 814, 671 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{31}H_{27}N_2O_5S_2$: 571.1356; found: 571.1350;

$[\alpha]_D^{23}$ = -80.7 (*c* = 0.1, CH_2Cl_2);

The enantiomeric ratio of the product was determined by HPLC (Column Daicel Chiracel IC; ^{i}PrOH/Hexane = 50/50; flow rate = 1.0 mL/min; t_{R1} = 14.95 min, 94.5%; t_{R2} = 17.16 min, 5.5%).

(2*S*,4*S*)-8-ethyl-4-phenyl-1-tosyl-3,4-dihydro-1*H*,2'*H*-spiro[benzofuro[3,2-*b*]pyridine-2,3'-benzo[*d*]isothiazole] 1',1'-dioxide (3ca)



White solid, isolated yield: 91% (53 mg);

m.p.: 53.6-54.1 °C;

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.84-7.82 (m, 1H), 7.74-7.61 (m, 5H), 7.34-7.20 (m, 6H), 7.14 (d, J = 8.1 Hz, 2H), 7.00 (dd, J = 8.5, 1.8 Hz, 1H), 6.65 (s, 1H), 6.45 (s, 1H), 4.87 (dd, J = 9.3, 5.7 Hz, 1H), 3.87 (dd, J = 16.6, 9.2 Hz, 1H), 3.58 (dd, J = 16.6, 5.7 Hz, 1H), 2.53 (q, J = 7.6 Hz, 2H), 2.30 (s, 3H), 1.11 (t, J = 7.6 Hz, 3H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 174.1, 154.2, 151.7, 143.9, 139.2 (2C), 138.9, 136.6, 134.0, 133.7, 130.7, 129.7, 128.7, 128.0, 127.53, 127.48, 125.6, 124.8, 124.1, 122.4, 117.9, 113.7, 110.8, 39.0, 35.5, 28.6, 21.4, 16.0;

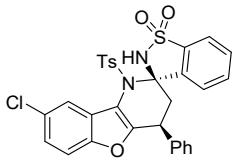
IR (neat): v 3632, 2341, 1649, 1502, 1453, 1337, 1167, 1025, 803, 670 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{32}H_{29}N_2O_5S_2$: 585.1512; found: 585.1511;

$[\alpha]_D^{23}$ = -79.3 (c = 0.1, CH_2Cl_2);

The enantiomeric ratio of the product was determined by HPLC (Column Daicel Chiracel IC; ^{i}PrOH/Hexane = 40/60; flow rate = 0.5 mL/min; t_{R1} = 38.37 min, 94.5%; t_{R2} = 42.96 min, 5.5%).

(2*S*,4*S*)-8-chloro-4-phenyl-1-tosyl-3,4-dihydro-1*H*,2'*H*-spiro[benzofuro[3,2-*b*]pyridine-2,3'-benzo[*d*]isothiazole] 1',1'-dioxide (3da)



Yellow foam, isolated yield: 91% (54 mg);

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.80-7.78 (m, 1H), 7.69-7.64 (m, 3H), 7.56 (d, J = 8.2 Hz, 2H), 7.27-7.23 (m, 5H), 7.17-7.02 (m, 4H), 6.73 (d, J = 2.1 Hz, 1H), 6.61 (s, 1H), 4.82 (dd, J = 9.6, 5.5 Hz, 1H), 3.85 (dd, J = 17.0, 9.5 Hz, 1H), 3.54 (dd, J = 17.0, 5.5 Hz, 1H), 2.29 (s, 3H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 174.0, 155.5, 151.5, 144.4, 139.1, 138.1, 136.2, 134.1, 133.8, 130.6, 129.8, 128.83, 128.80, 127.9, 127.6, 127.5, 127.0, 124.7, 124.1, 122.4, 119.2, 113.6, 112.2, 38.9, 35.4, 21.4;

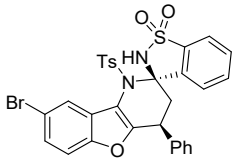
IR (neat): v 3523, 2366, 1706, 1456, 1340, 1265, 1170, 1033, 812, 757 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{30}H_{24}ClN_2O_5S_2$: 591.0810; found: 591.0799;

$[\alpha]_D^{23}$ = -75.3 (c = 0.1, CH_2Cl_2);

The enantiomeric ratio of the product was determined by HPLC (Column Daicel Chiracel IC; ^{i}PrOH/Hexane = 50/50; flow rate = 1.0 mL/min; t_{R1} = 11.78 min, 90.1%; t_{R2} = 13.69 min, 9.9%).

(2*S*,4*S*)-8-bromo-4-phenyl-1-tosyl-3,4-dihydro-1*H*,2'*H*-spiro[benzofuro[3,2-*b*]pyridine-2,3'-benzo[*d*]isothiazole] 1',1'-dioxide (3ea)



Yellow solid, isolated yield: 89% (56 mg);

m.p.: 129.2-129.8 °C;

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.85-7.83 (m, 1H), 7.74-7.67 (m, 3H), 7.60-7.58 (m, 2H), 7.33-7.28 (m, 5H), 7.23 (dd, J = 8.7, 2.0 Hz, 1H), 7.16-7.13 (m, 3H), 6.81 (d, J = 2.0 Hz, 1H), 6.53 (s, 1H), 4.88 (dd, J = 9.6, 5.3 Hz, 1H), 3.91 (dd, J = 16.9, 9.6 Hz, 1H), 3.58 (dd, J = 16.9, 5.4 Hz, 1H), 2.35 (s, 3H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 174.0, 155.5, 151.8, 144.5, 139.1, 138.5, 136.1, 134.1, 133.9, 130.6, 129.8, 128.8, 127.9, 127.7, 127.54, 127.50, 127.4, 124.1, 122.5, 122.1, 116.3, 113.4, 112.7, 38.6, 34.9, 22.1;

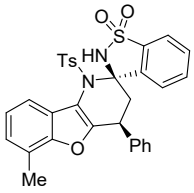
IR (neat): v 3521, 2405, 1807, 1598, 1452, 1340, 1174, 1053, 818, 731 cm^{-1};

HRMS (ESI): m/z [M + H]$^+$ calcd. for $C_{30}H_{24}BrN_2O_5S_2$: 635.0305; found: 635.0290;

$[\alpha]_D^{23}$ = 35.7 (c = 0.1, CH_2Cl_2);

The enantiomeric ratio of the product was determined by HPLC (Column Daicel Chiracel IC; ^{i}PrOH/Hexane = 30/70; flow rate = 1.0 mL/min; t_{R1} = 27.50 min, 94.0%; t_{R2} = 31.62 min, 6.0%).

(2*S*,4*S*)-6-methyl-4-phenyl-1-tosyl-3,4-dihydro-1*H*,2'*H*-spiro[benzofuro[3,2-*b*]pyridine-2,3'-benzo[*d*]isothiazole] 1',1'-dioxide (3fa)



Yellow solid, isolated yield: 85% (48 mg);

m.p.: 133.8-134.2 °C;

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.80-7.78 (m, 1H), 7.70-7.56 (m, 5H), 7.27-7.22 (m, 5H), 7.10 (d, , J = 8.1 Hz 2H), 6.95-6.84 (m, 3H), 6.50 (s, 1H), 4.80 (dd, J = 9.2, 5.9 Hz, 1H), 3.81 (dd, J = 16.6, 9.1 Hz, 1H), 3.55 (dd, J = 16.6, 5.9 Hz, 1H), 2.38 (s, 3H), 2.28 (s, 3H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 174.0, 153.3, 152.1, 143.8, 139.3, 138.9, 136.5, 133.9, 133.7, 130.7, 129.7, 128.7, 128.0, 127.5, 127.4, 125.5, 125.2, 124.0, 123.1, 122.4, 121.2, 117.0, 114.1, 39.2, 36.4, 21.4, 14.5;

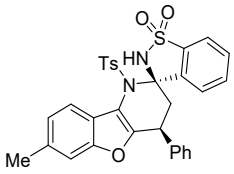
IR (neat): v 3454, 2364, 1559, 1457, 1342, 1175, 1098, 908, 776, 664 cm^{-1};

HRMS (ESI): m/z [M + H]$^+$ calcd. for $C_{31}H_{27}N_2O_5S_2$: 571.1356; found: 571.1348;

$[\alpha]_D^{23}$ = -30.0 (*c* = 0.1, CH_2Cl_2);

The enantiomeric ratio of the product was determined by HPLC (Column Daicel Chiracel IC; ^{i}PrOH/Hexane = 50/50; flow rate = 1.0 mL/min; t_{R1} = 15.72 min, 95.4%; t_{R2} = 19.90 min, 4.6%).

(2*S*,4*S*)-7-methyl-4-phenyl-1-tosyl-3,4-dihydro-1*H*,2'*H*-spiro[benzofuro[3,2-*b*]pyridine-2,3'-benzo[*d*]isothiazole] 1',1'-dioxide (3ga)



White solid, isolated yield: 93% (53 mg);

m.p.: 183.4-184.0 °C;

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.86-7.84 (m, 1H), 7.72-7.65 (m, 3H), 7.62-7.59 (m, 2H), 7.30-7.27 (m, 2H), 7.25-7.22 (m, 3H), 7.14-7.12 (m, 3H), 7.00-6.95 (m, 1H), 6.89-6.86 (m, 1H), 6.36 (s, 1H), 4.77 (dd, *J* = 9.3, 5.6 Hz, 1H), 3.81 (dd, *J* = 16.8, 9.3 Hz, 1H), 3.55 (dd, *J* = 16.8, 5.7 Hz, 1H), 2.38 (s, 3H), 2.31 (s, 3H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 173.9, 153.7, 152.9, 143.9, 139.4, 138.9, 136.5, 135.0, 133.9, 133.7, 130.7, 129.7, 128.7, 127.9, 127.5, 127.4, 124.6, 124.0, 123.3, 122.5, 119.2, 113.9, 111.4, 38.9, 35.6, 21.55, 21.46;

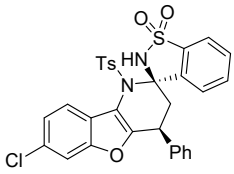
IR (neat): *v* 3641, 2347, 1742, 1655, 1514, 1464, 1403, 1242, 859, 674 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{31}H_{27}N_2O_5S_2$: 571.1356; found: 571.1350;

$[\alpha]_D^{23}$ = -14.7 (*c* = 0.1, CH_2Cl_2);

The enantiomeric ratio of the product was determined by HPLC (Column Daicel Chiracel IC; ^{i}PrOH/Hexane = 50/50; flow rate = 1.0 mL/min; t_{R1} = 16.51 min, 98.0%; t_{R2} = 22.58 min, 2.0%).

(2*S*,4*S*)-7-chloro-4-phenyl-1-tosyl-3,4-dihydro-1*H*,2'*H*-spiro[benzofuro[3,2-*b*]pyridine-2,3'-benzo[*d*]isothiazole] 1',1'-dioxide (3ha)



Yellow foam, isolated yield: 89% (53 mg);

^{1}H NMR (400 MHz, DMSO-d_6): δ 10.16 (s, 1H), 8.15-8.13 (m, 1H), 8.09-8.06 (m, 1H), 7.91-7.88 (m, 2H), 7.64 (d, *J* = 1.8 Hz, 1H), 7.58-7.56 (m, 2H), 7.34-7.16 (m, 9H), 4.89 (dd, *J* = 9.9, 4.5 Hz, 1H), 4.16 (dd, *J* = 18.7, 10.0 Hz, 1H), 2.97 (dd, *J* = 18.7, 4.5 Hz, 1H), 1.94 (s, 3H);

^{13}C NMR (101 MHz, DMSO-d_6): δ 175.5, 155.3, 153.5, 143.9, 139.1, 138.8, 137.0, 135.2, 134.9, 130.9, 130.2, 129.7, 128.8, 128.5, 127.52, 127.48, 126.2, 125.3, 124.0, 122.7, 121.6, 113.7, 112.2, 37.7, 34.3, 21.0;

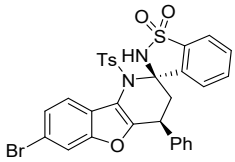
IR (neat): ν 3634, 2345, 1739, 1703, 1653, 1541, 1524, 1052, 816, 672 cm^{-1};

HRMS (ESI): m/z [M + H]$^+$ calcd. for $C_{30}H_{24}ClN_2O_5S_2$: 591.0810; found: 591.0795;

$[\alpha]_D^{23}$ = -51.3 (c = 0.1, CH_2Cl_2);

The enantiomeric ratio of the product was determined by HPLC (Column Daicel Chiracel AD; ^{i}PrOH/Hexane = 50/50; flow rate = 1.0 mL/min; t_{R1} = 8.16 min, 6.9%; t_{R2} = 10.11 min, 93.1%).

(2*S*,4*S*)-7-bromo-4-phenyl-1-tosyl-3,4-dihydro-1*H*,2'*H*-spiro[benzofuro[3,2-*b*]pyridine-2,3'-benzo[*d*]isothiazole] 1',1'-dioxide (3ia)



Yellow foam, isolated yield: 91% (58 mg);

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.85-7.84 (m, 1H), 7.71-7.68 (m, 3H), 7.60-7.57 (m, 2H), 7.48 (d, J = 1.6 Hz, 1H), 7.29-7.11 (m, 8H), 7.01 (d, J = 9.6 Hz, 1H), 6.62 (s, 1H), 4.76 (dd, J = 9.6, 5.2 Hz, 1H), 3.82 (dd, J = 17.2, 9.6 Hz, 1H), 3.54 (dd, J = 17.2, 5.3 Hz, 1H), 2.31 (s, 3H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 173.5, 154.0, 153.4, 144.1, 139.2, 138.4, 136.2, 134.0, 133.9, 130.6, 129.8, 128.8, 127.8, 127.6, 127.4, 126.6, 124.9, 124.0, 122.5, 120.9, 117.9, 114.7, 114.2, 38.6, 35.5, 21.5;

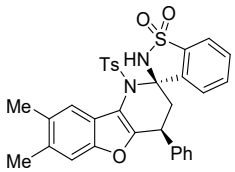
IR (neat): ν 3642, 2347, 1705, 1654, 1514, 1464, 1402, 1281, 1019, 754 cm^{-1};

HRMS (ESI): m/z [M + H]$^+$ calcd. for $C_{30}H_{24}BrN_2O_5S_2$: 635.0305; found: 635.0301;

$[\alpha]_D^{23}$ = -64.0 (c = 0.1, CH_2Cl_2);

The enantiomeric ratio of the product was determined by HPLC (Column Daicel Chiracel IC; ^{i}PrOH/Hexane = 50/50; flow rate = 1.0 mL/min; t_{R1} = 12.91 min, 95.1%; t_{R2} = 20.19 min, 4.9%).

(2*S*,4*S*)-7,8-dimethyl-4-phenyl-1-tosyl-3,4-dihydro-1*H*,2'*H*-spiro[benzofuro[3,2-*b*]pyridine-2,3'-benzo[*d*]isothiazole] 1',1'-dioxide (3ja)



Yellow foam, isolated yield: 93% (54 mg);

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.86-7.83 (m, 1H), 7.72-7.65 (m, 3H), 7.62-7.60 (m, 2H), 7.30-7.27 (m, 3H), 7.24-7.21 (m, 2H), 7.14-7.09 (m, 3H), 6.68 (s, 1H), 6.33 (s, 1H), 4.75 (dd, *J* = 9.3, 5.6 Hz, 1H), 3.81 (dd, *J* = 16.7, 9.4 Hz, 1H), 3.54 (dd, *J* = 16.7, 5.6 Hz, 1H), 2.31 (s, 3H), 2.26 (s, 3H), 2.13 (s, 3H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 174.0, 152.8, 152.2, 143.9, 143.0, 139.1, 136.6, 133.9, 133.8, 133.7, 131.8, 130.8, 129.7, 128.7, 127.9, 127.6, 127.4, 124.0, 123.5, 122.4, 119.5, 113.5, 111.6, 38.9, 35.6, 21.4, 20.3, 19.6;

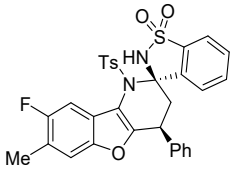
IR (neat): *v* 3489, 2344, 1746, 1571, 1346, 1229, 1182, 1096, 811, 661 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{32}H_{29}N_2O_5S_2$: 585.1512; found: 585.1499;

$[\alpha]_D^{23}$ = -34.0 (*c* = 0.1, CH_2Cl_2);

The enantiomeric ratio of the product was determined by HPLC (Column Daicel Chiracel AD; ^{i}PrOH/Hexane = 50/50; flow rate = 1.0 mL/min; t_{R1} = 8.53 min, 5.0%; t_{R2} = 11.18 min, 95.0%).

(2*S*,4*S*)-8-fluoro-7-methyl-4-phenyl-1-tosyl-3,4-dihydro-1*H*,2'*H*-spiro[benzofuro[3,2-*b*]pyridine-2,3'-benzo[*d*]isothiazole] 1',1'-dioxide (3ka)



Yellow foam, isolated yield: 93% (55 mg);

^{1}H NMR (400 MHz, DMSO-d_6): δ 10.08 (s, 1H), 8.14-8.06 (m, 2H), 7.91-7.86 (m, 2H), 7.58 (d, *J* = 8.3 Hz, 2H), 7.38-7.33 (m, 3H), 7.26-7.17 (m, 5H), 6.88 (d, *J* = 9.5 Hz, 1H), 4.89 (dd, *J* = 9.9, 4.6 Hz, 1H), 4.15 (dd, *J* = 18.6, 10.0 Hz, 1H), 2.98 (dd, *J* = 18.6, 4.6 Hz, 1H), 2.25 (d, *J* = 2.2 Hz, 3H), 1.96 (s, 3H);

^{13}C NMR (101 MHz, DMSO-d_6): δ 175.1, 158.9 (d, *J* = 237.7 Hz), 155.3, 149.3, 143.8, 139.3, 138.8, 137.1, 135.1, 134.8, 130.9, 130.2, 128.8, 128.5, 127.6, 127.4, 126.1, 124.9 (d, *J* = 10.8 Hz), 122.7, 122.3 (d, *J* = 21.6 Hz), 113.8, 113.7, 105.6 (d, *J* = 27.3 Hz), 37.8, 34.4, 21.0, 15.2 (d, *J* = 3.8 Hz);

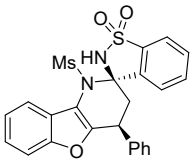
IR (neat): *v* 3508, 2367, 1563, 1344, 1266, 1096, 970, 802, 757, 698 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{31}H_{26}FN_2O_5S_2$: 589.1262; found: 589.1259;

$[\alpha]_D^{23}$ = -8.3 (*c* = 0.1, CH_2Cl_2);

The enantiomeric ratio of the product was determined by HPLC (Column Daicel Chiracel IC; ^{i}PrOH/Hexane = 50/50; flow rate = 1.0 mL/min; t_{R1} = 12.66 min, 94.9 %; t_{R2} = 16.47 min, 5.1%).

(2*S*,4*S*)-1'-(methylsulfonyl)-4'-phenyl-3',4'-dihydro-1'*H*,2*H*-spiro[benzo[*d*]isothiazole-3,2'-dibenzo[*b*,*d*]furan] 1,1-dioxide (3la)



Yellow foam, isolated yield: 76% (36 mg);

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.85-7.83 (m, 1H), 7.76-7.68 (m, 3H), 7.56-7.54 (m, 3H), 7.43-7.35 (m, 3H), 7.31-7.27 (m, 2H), 7.24-7.22 (m, 1H), 6.37 (s, 1H), 5.21 (dd, J = 9.8, 5.1 Hz, 1H), 4.05 (dd, J = 16.4, 9.9 Hz, 1H), 3.65 (dd, J = 16.7, 5.2 Hz, 1H), 2.96 (s, 3H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 174.7, 154.1, 153.3, 140.0, 139.0, 134.7, 133.8, 131.2, 128.6, 128.0, 127.8, 125.7, 125.0, 124.0, 123.7, 122.9, 119.4, 113.8, 111.7, 40.4, 39.3, 36.1;

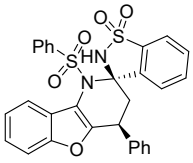
IR (neat): v 3612, 2364, 1718, 1651, 1563, 1342, 1075, 911, 751, 671 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{24}H_{21}N_2O_5S_2$: 481.0886; found: 481.0896;

$[\alpha]_D^{23}$ = -19.3 (c = 0.1, CH_2Cl_2);

The enantiomeric ratio of the product was determined by HPLC (Column Daicel Chiracel IC; ^{i}PrOH/Hexane = 50/50; flow rate = 1.0 mL/min; t_{R1} = 19.23 min, 5.1%; t_{R2} = 22.07 min, 94.9%).

(2*S*,4*S*)-4-phenyl-1-(phenylsulfonyl)-3,4-dihydro-1*H*,2'*H*-spiro[benzofuro[3,2-*b*]pyridine-2,3'-benzo[*d*]isothiazole] 1',1'-dioxide (3ma)



Yellow foam, isolated yield: 91% (49 mg);

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.84-7.82 (m, 1H), 7.75-7.66 (m, 5H), 7.47-7.43 (m, 1H), 7.35-7.25 (m, 8H), 7.17-7.13 (m, 1H), 7.02-6.94 (m, 2H), 4.86 (dd, J = 9.4, 5.6 Hz, 1H), 3.87 (dd, J = 16.7, 9.4 Hz, 1H), 3.58 (dd, J = 16.7, 5.6 Hz, 1H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 174.1, 154.3, 153.1, 139.4, 139.2, 138.8, 134.0, 133.8, 133.0, 130.7, 129.1, 128.8, 128.0, 127.6, 127.4, 125.6, 124.6, 124.0, 123.2, 122.4, 119.3, 113.8, 111.2, 39.4, 35.5;

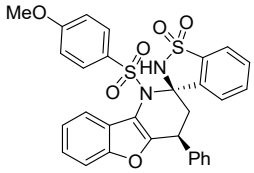
IR (neat): v 3536, 2307, 2079, 1780, 1258, 1190, 1074, 978, 764, 675 cm^{-1};

HRMS (ESI): m/z $[M + H]^+$ calcd. for $C_{29}H_{23}N_2O_5S_2$: 543.1043; found: 543.1035;

$[\alpha]_D^{23}$ = -34.7 (c = 0.1, CH_2Cl_2);

The enantiomeric ratio of the product was determined by HPLC (Column Daicel Chiracel ID; ^{i}PrOH/Hexane = 50/50; flow rate = 0.5 mL/min; t_{R1} = 30.35 min, 98.2%; t_{R2} = 39.48 min, 1.8%).

(2*S*,4*S*)-1-((4-methoxyphenyl)sulfonyl)-4-phenyl-3,4-dihydro-1*H*,2'*H*-spiro[benzofuro[3,2-b]pyridine-2,3'-benzo[*d*]isothiazole] 1',1'-dioxide (3na)



Yellow foam, isolated yield: 87% (50 mg);

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.80-7.78 (m, 1H), 7.69-7.60 (m, 5H), 7.31-7.22 (m, 6H), 7.17-7.10 (m, 2H), 7.05-7.01 (m, 1H), 6.76 (d, J = 9.0 Hz, 2H), 6.57 (s, 1H), 4.82 (dd, J = 9.2, 5.8 Hz, 1H), 3.82 (dd, J = 16.9, 9.2 Hz, 1H), 3.72 (s, 3H), 3.56 (dd, J = 16.9, 5.8 Hz, 1H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 174.1, 163.1, 153.5, 153.2, 139.1, 138.8, 134.0, 133.7, 130.8, 130.6, 129.5, 128.7, 127.9, 127.5, 125.7, 124.5, 124.1, 123.1, 122.3, 119.7, 114.2, 114.0, 111.2, 55.5, 38.8, 35.6;

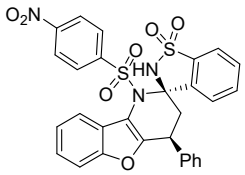
IR (neat): v 3268, 2365, 1602, 1460, 1263, 1170, 1096, 1028, 807, 676 cm^{-1};

HRMS (ESI): m/z [M + H]$^+$ calcd. for $C_{30}H_{25}N_2O_6S_2$: 573.1149; found: 573.1145;

$[\alpha]_D^{23}$ = -52.0 (c = 0.1, CH_2Cl_2);

The enantiomeric ratio of the product was determined by HPLC (Column Daicel Chiracel AD; ^{i}PrOH/Hexane = 30/70; flow rate = 1.0 mL/min; t_{R1} = 23.79 min, 95.6%; t_{R2} = 33.75 min, 4.4%).

(2*S*,4*S*)-1-((4-nitrophenyl)sulfonyl)-4-phenyl-3,4-dihydro-1*H*,2'*H*-spiro[benzofuro[3,2-*b*]pyridine-2,3'-benzo[*d*]isothiazole] 1',1'-dioxide (3oa)



Yellow foam, isolated yield: 84% (49 mg);

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.99-7.96 (m, 2H), 7.84-7.82 (m, 3H), 7.71-7.64 (m, 3H), 7.38-7.33 (m, 2H), 7.23-7.12 (m, 8H), 4.77 (dd, J = 10.4, 4.2 Hz, 1H), 3.89 (dd, J = 17.4, 10.4 Hz, 1H), 3.48 (dd, J = 17.4, 4.4 Hz, 1H);

^{13}C NMR (101 MHz, $CDCl_3$): δ 174.2, 153.4, 152.9, 150.0, 144.6, 139.02, 138.95, 134.03, 133.97, 130.5, 128.8, 128.6, 127.7, 127.4, 125.4, 125.0, 124.1, 123.9, 123.6, 122.6, 119.9, 113.9, 111.4, 38.0, 36.4;

IR (neat): v 3302, 2367, 1606, 1451, 1345, 1175, 1095, 1018, 776, 692 cm^{-1};

HRMS (ESI): m/z [M + H]$^+$ calcd. for $C_{29}H_{22}N_3O_7S_2$: 588.0894; found: 588.0892;

$[\alpha]_D^{23}$ = 35.7 (c = 0.1, CH_2Cl_2);

The enantiomeric ratio of the product was determined by HPLC (Column Daicel Chiracel AD; ^{i}PrOH/Hexane = 50/50; flow rate = 1.0 mL/min; t_{R1} = 9.52 min, 92.7%; t_{R2} = 15.14 min, 7.3%).

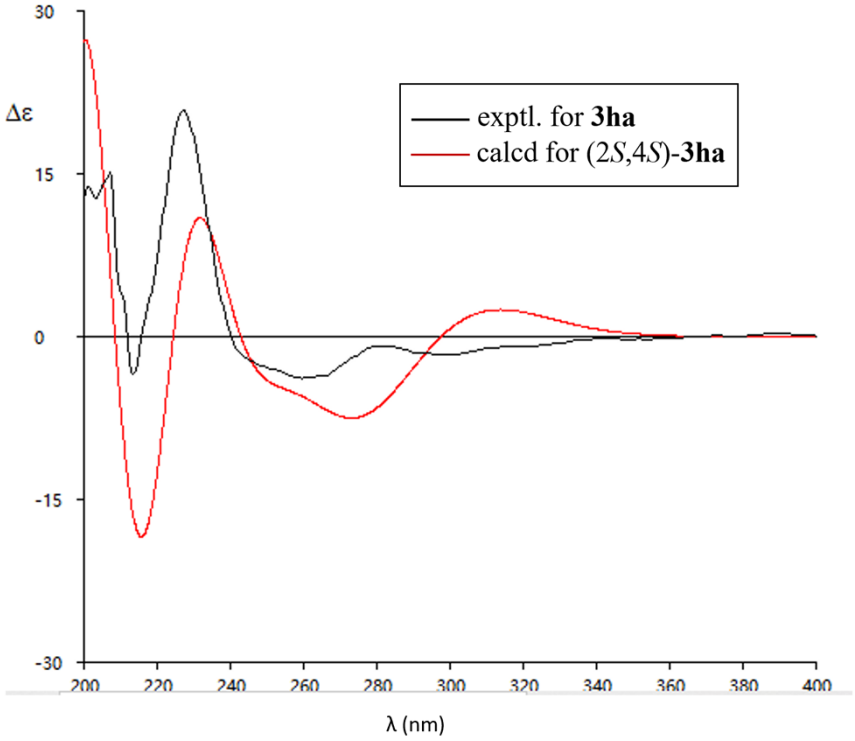
3. The ECD spectra data of 3ha

3.1 Theory and calculation details

The calculations were performed by using the density functional theory (DFT) as carried out in the Gaussian 09.[3] Conformational searches were run by employing the "systematic" procedure implemented in Spartan'14[4] using MMFF. All MMFF minima were reoptimized with DFT calculations at the B3LYP/6-31G(d) level. Solvent effects of methanol solution were evaluated at the same DFT level by using the SCRF/PCM method.[5] TDDFT[6] at B3LYP/6-31G(d) was employed to calculate the electronic excitation energies and rotational strengths in methanol. The stable conformations obtained at the B3LYP/6-31G(d) level were further used in magnetic shielding constants at the B3LYP/6-311++G(2d,p) level. The overall calculated ECD curves were weighted by Boltzmann distribution (with a half-bandwidth of 0.30 eV). The calculated ECD spectrum were produced by SpecDis 1.70.1 software.[7]

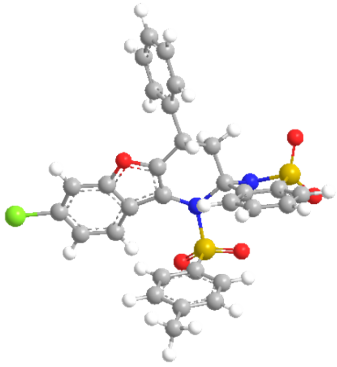
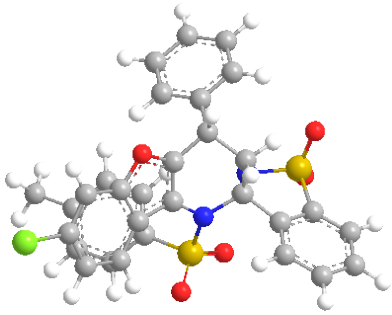
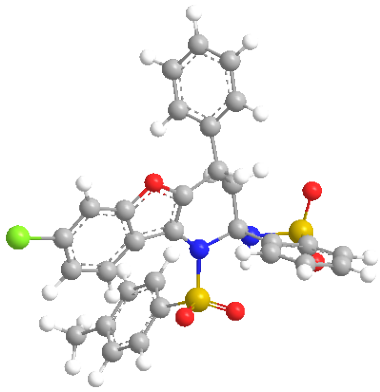
3.2 The ECD spectra of product 3ha

In order to further confirm the absolute configuration of **3ha** in experiment, we have compared the ECD spectra in experiment with the calculated ECD spectra of the (2*S*,4*S*)-configurational product. The absolute configuration of product **3ha** was assigned by comparison between its experimental and calculated ECD spectra to be the (2*S*,4*S*)-configuration.



Supplementary Figure 1. Comparison of the calculated ECD of compound (2*S*,4*S*)-**3ha** with the experimental one of compound **3ha**.

DFT-optimized structures and thermodynamic parameters for low-energy conformers of **3ha**

Conformers	Conf. A	Conf. B	Conf. C
DFT-optimized structures			
Population	9.46%	54.31%	36.23%
Total energy (a.u.)	-2899.08461488	-2899.08626309	-2899.08588121
Sum of electronic and zero-point energies (a.u.)	-2898.608944	-2898.610662	-2898.610386
Sum of electronic and thermal energies (a.u.)	-2898.575815	-2898.577534	-2898.577158
Sum of electronic and thermal enthalpies (a.u.)	-2898.574871	-2898.576590	-2898.576214
Sum of electronic and thermal free energies (a.u.)	-2898.675881	-2898.677128	-2898.677162

Optimized Z-matrixes of **3ha** in the gas phase (Å) at B3LYP/6-31G(d) level

Conf. A				Conf. B				Conf. C			
C	-4.39767	-1.45064	-1.5877	C	4.361246	-2.0788	-0.46587	C	4.333347	1.178917	-0.97881
C	-5.15512	-0.7234	-0.65615	C	4.885035	-1.3552	-1.54928	C	4.245053	2.577984	-1.05577
C	-4.56869	0.201872	0.198151	C	4.108745	-0.46886	-2.28744	C	3.036268	3.245079	-0.9024
C	-3.19295	0.350602	0.079449	C	2.786788	-0.33949	-1.88264	C	1.92647	2.443539	-0.66727
C	-2.37397	-0.37819	-0.80977	C	2.216978	-1.02156	-0.78625	C	1.953791	1.035482	-0.58751
C	-3.01869	-1.2861	-1.67313	C	3.035362	-1.91842	-0.07724	C	3.200478	0.406348	-0.75102
O	-2.46731	1.253662	0.796653	O	1.864264	0.447986	-2.5114	O	0.668167	2.926453	-0.46832
C	-1.16597	1.106103	0.397525	C	0.697111	0.305756	-1.80156	C	-0.13378	1.833382	-0.26064
C	-1.02367	0.119645	-0.5423	C	0.839801	-0.54858	-0.75145	C	0.567524	0.662901	-0.33198
C	-0.13988	2.117777	0.793346	C	-0.58915	0.833011	-2.32952	C	-1.56718	2.005063	0.10806
C	0.836149	2.13304	-0.39947	C	-1.62082	-0.25509	-1.92317	C	-1.92106	0.710336	0.862824
C	1.386637	0.738865	-0.79699	C	-1.65106	-0.63402	-0.41796	C	-1.5368	-0.59415	0.11697
N	0.252223	-0.19222	-1.11124	N	-0.26681	-0.89018	0.07599	N	-0.05452	-0.61087	-0.11473
C	2.358309	0.245869	0.293568	C	-2.5566	-1.86589	-0.25059	C	-2.38106	-0.76033	-1.15928
C	3.69545	0.487927	-0.01376	C	-3.86621	-1.5468	0.095971	C	-3.52586	-1.52874	-0.95757
S	3.818848	1.290616	-1.60973	S	-4.02252	0.228037	0.28018	S	-3.56952	-2.1201	0.732611
N	2.189995	0.96139	-2.03716	N	-2.31612	0.487138	0.325766	N	-1.91798	-1.70808	1.038682
C	2.045821	-0.29505	1.541944	C	-2.21606	-3.19891	-0.46986	C	-2.15237	-0.20963	-2.42022
C	3.07951	-0.59344	2.435477	C	-3.2005	-4.17968	-0.32205	C	-3.07711	-0.4474	-3.44185
C	4.41508	-0.35049	2.100039	C	-4.5121	-3.83908	0.028282	C	-4.2237	-1.21518	-3.21452
C	4.738113	0.204576	0.859936	C	-4.86315	-2.50435	0.240024	C	-4.462	-1.76985	-1.95518
O	3.986914	2.727492	-1.38271	O	-4.57489	0.788622	-0.95696	O	-4.44785	-1.2572	1.525159
O	4.697739	0.585781	-2.54178	O	-4.57683	0.6245	1.573597	O	-3.69204	-3.57425	0.823942
Cl	-6.89267	-0.97705	-0.57917	Cl	6.570986	-1.58502	-1.99402	Cl	5.705558	3.511361	-1.35046
C	0.536624	-2.88848	-0.05834	C	1.065444	0.117274	2.291953	C	1.836717	-2.5783	0.280836
C	1.725929	-3.38221	0.481807	C	0.730601	1.444988	2.010848	C	1.622681	-2.47032	1.656011
C	1.664547	-4.25245	1.568354	C	1.52287	2.462862	2.53313	C	2.543874	-3.04556	2.52865
C	0.437303	-4.6344	2.126765	C	2.63733	2.180264	3.337808	C	3.670037	-3.73197	2.052458
C	-0.74073	-4.12461	1.559698	C	2.94043	0.839604	3.610063	C	3.850928	-3.83436	0.665649
C	-0.70421	-3.26598	0.464474	C	2.165357	-0.19585	3.091566	C	2.944006	-3.26493	-0.22499
C	0.377771	-5.5988	3.286545	C	3.50259	3.294402	3.874468	C	4.676108	-4.32378	3.00942
S	0.628476	-1.84093	-1.51225	S	0.007319	-1.21953	1.739378	S	0.620035	-1.99334	-0.90036
O	2.028369	-1.8066	-1.94892	O	0.748582	-2.47508	1.866825	O	1.310845	-1.59697	-2.12676
O	-0.41547	-2.28144	-2.43233	O	-1.30842	-1.10454	2.382193	O	-0.45938	-2.98908	-0.95557
C	-0.69729	3.508862	1.070547	C	-0.91634	2.283602	-1.95705	C	-1.8692	3.237675	0.950949
C	-0.33648	4.180699	2.243042	C	-2.16299	2.831784	-2.28642	C	-2.95382	4.056261	0.61951
C	-0.7964	5.474371	2.496591	C	-2.45048	4.166551	-2.00706	C	-3.27985	5.163743	1.40442
C	-1.62884	6.112022	1.577358	C	-1.4924	4.983073	-1.40217	C	-2.51904	5.468238	2.53285
C	-1.99733	5.448794	0.404473	C	-0.24445	4.450904	-1.08236	C	-1.4319	4.658939	2.870838
C	-1.53463	4.158444	0.153026	C	0.040951	3.111553	-1.36012	C	-1.11064	3.552217	2.086629
H	-4.89891	-2.14451	-2.25359	H	5.00234	-2.77186	0.067825	H	5.298242	0.700255	-1.10428
H	-5.14256	0.788157	0.905661	H	4.50149	0.08153	-3.1339	H	2.955376	4.324088	-0.95505
H	-2.45669	-1.84761	-2.4042	H	2.640048	-2.49055	0.751202	H	3.302181	-0.66764	-0.7081
H	0.394807	1.794413	1.696453	H	-0.52984	0.790251	-3.42703	H	-2.18135	2.067998	-0.8018
H	0.330831	2.541612	-1.27883	H	-2.63675	0.044389	-2.18672	H	-1.40329	0.693809	1.826366
H	1.69768	2.77429	-0.19749	H	-1.38862	-1.16027	-2.49363	H	-2.99171	0.664399	1.073113
H	2.226338	0.096022	-2.58034	H	-2.10174	0.377581	1.321797	H	-1.41755	-2.55409	0.750953
H	1.016965	-0.51103	1.8117	H	-1.19485	-3.47137	-0.71888	H	-1.25353	0.365907	-2.61893
H	2.837739	-1.02806	3.401142	H	-2.9399	-5.22346	-0.47192	H	-2.89384	-0.03614	-4.43031
H	5.204562	-0.59209	2.805637	H	-5.26046	-4.61736	0.144715	H	-4.92626	-1.39272	-4.02332
H	5.768125	0.402983	0.580379	H	-5.87251	-2.22311	0.523469	H	-5.33569	-2.38534	-1.76497
H	2.677122	-3.09509	0.04894	H	-0.12197	1.690682	1.385256	H	0.755969	-1.94169	2.038702

H	2.588537	-4.64451	1.985671	H	1.267242	3.495742	2.311466	H	2.382398	-2.95949	3.600048
H	-1.70365	-4.41535	1.972045	H	3.795517	0.599712	4.236702	H	4.713278	-4.36899	0.275696
H	-1.62629	-2.91157	0.018153	H	2.40437	-1.23189	3.303777	H	3.092954	-3.34483	-1.29697
H	0.195769	-6.62241	2.93389	H	2.91618	4.197806	4.070639	H	4.204865	-4.62468	3.950423
H	1.316068	-5.60897	3.849743	H	4.002182	3.002033	4.803347	H	5.170953	-5.20013	2.578966
H	-0.4338	-5.34559	3.976794	H	4.284972	3.563436	3.152591	H	5.458807	-3.59385	3.254667
H	0.312709	3.689119	2.964343	H	-2.92881	2.213355	-2.74435	H	-3.55063	3.824754	-0.25991
H	-0.50357	5.980577	3.412491	H	-3.42869	4.566706	-2.25897	H	-4.12679	5.787389	1.131235
H	-1.98942	7.118352	1.771955	H	-1.71762	6.023782	-1.18535	H	-2.76884	6.330725	3.144708
H	-2.6468	5.937183	-0.31697	H	0.515251	5.077615	-0.62163	H	-0.83171	4.890308	3.746767
H	-1.83323	3.652074	-0.76134	H	1.021616	2.713679	-1.11562	H	-0.25847	2.933091	2.356033

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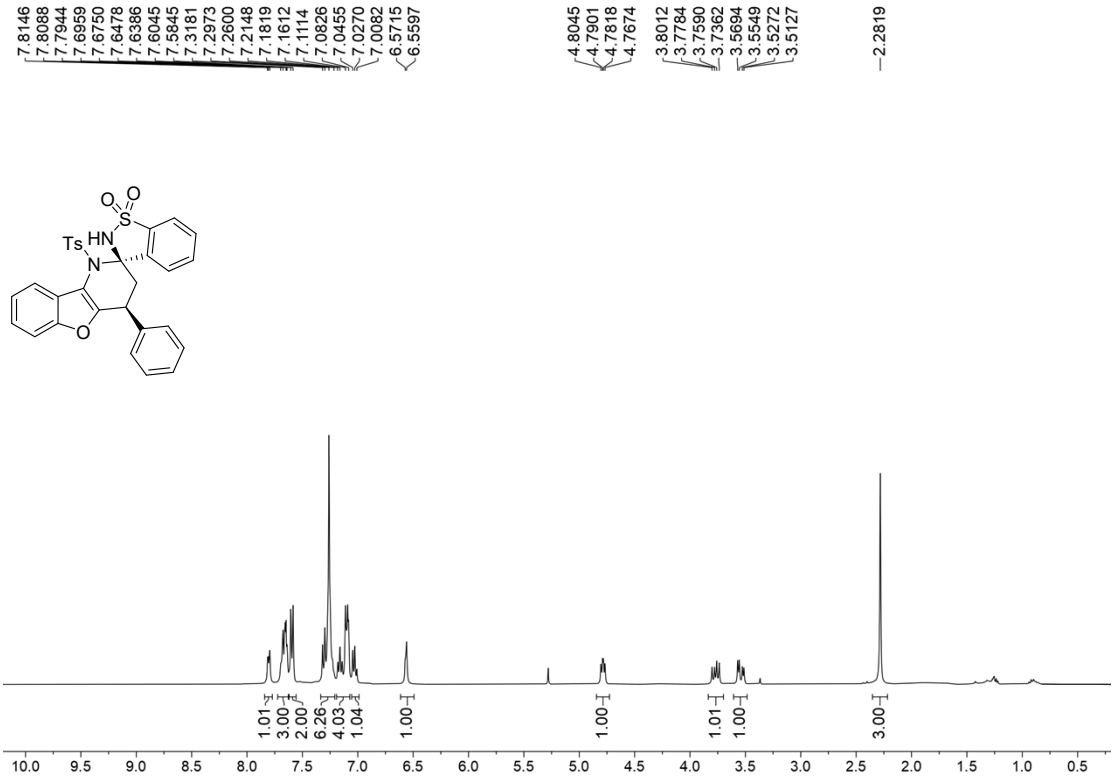
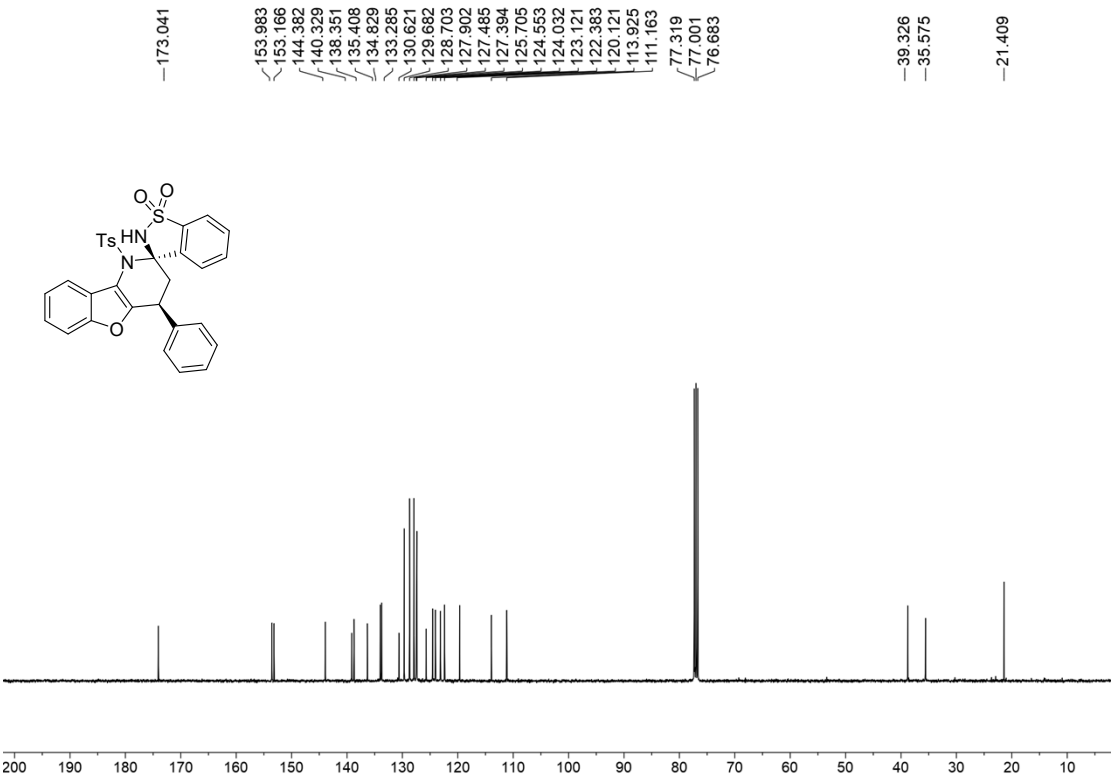
5. Copies of NMR spectra and HPLC spectra

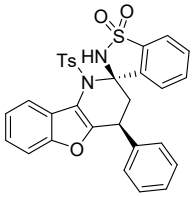
^{1}H NMR of 3aa (400 MHz, $CDCl_3$)

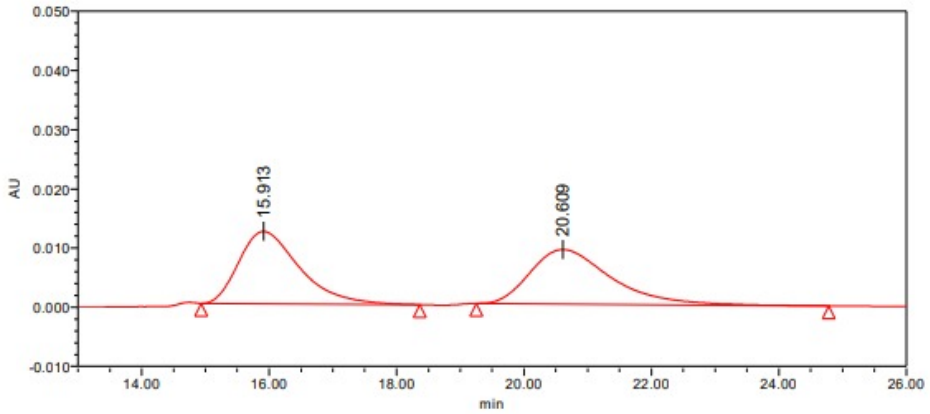


^{13}C NMR of 3aa (101 MHz, $CDCl_3$)



HPLC spectrum of 3aa





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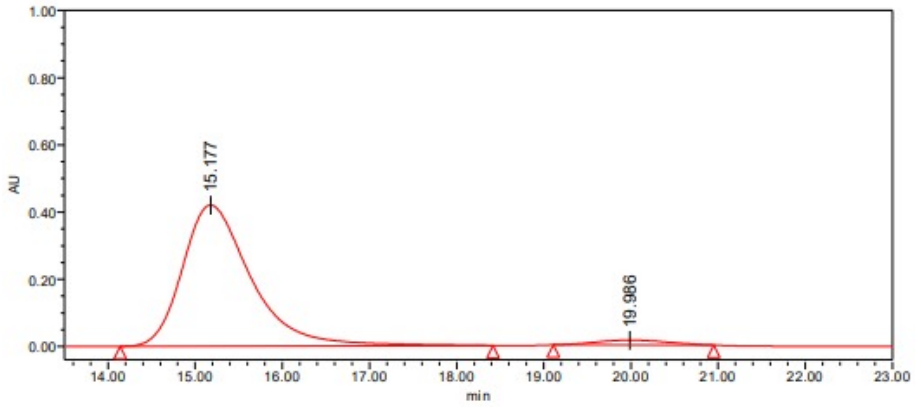

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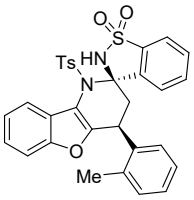
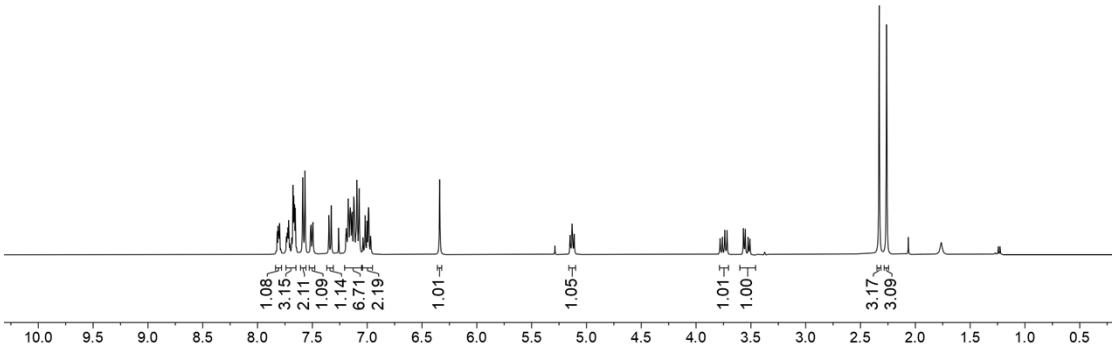
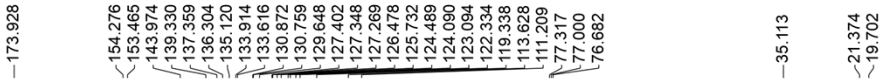
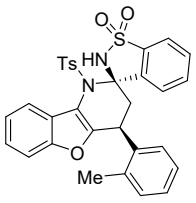
^{1}H NMR of 3ab (400 MHz, $CDCl_3$)

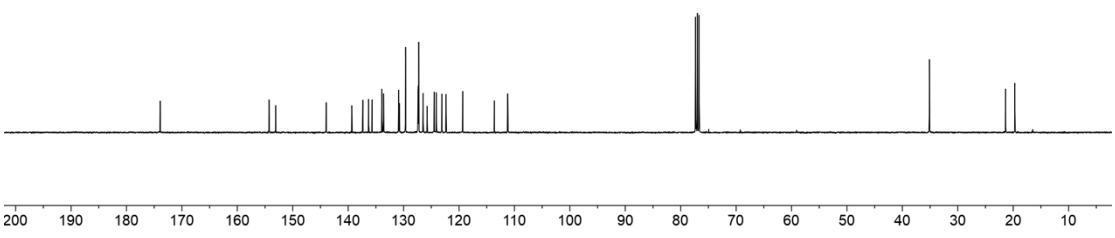




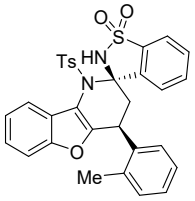
^{13}C NMR of 3ab (101 MHz, $CDCl_3$)

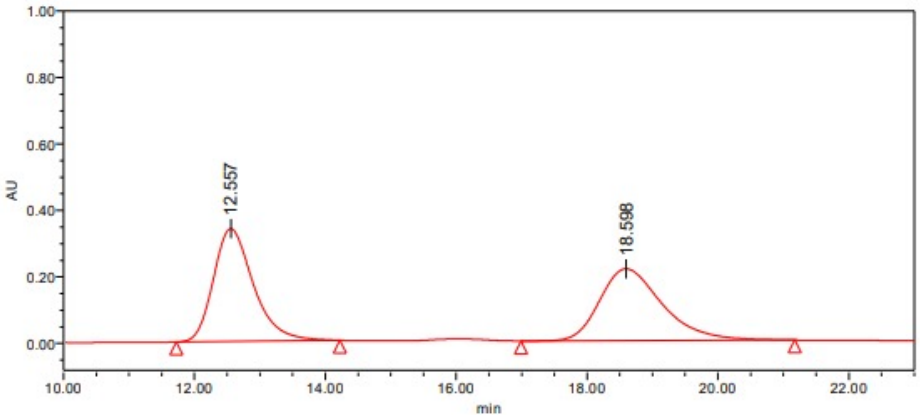






HPLC spectrum of 3ab





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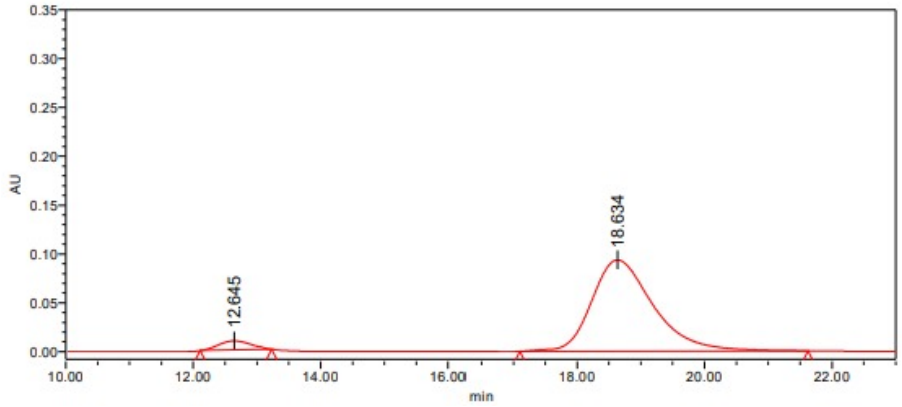
2	18.598	14402726	49.99



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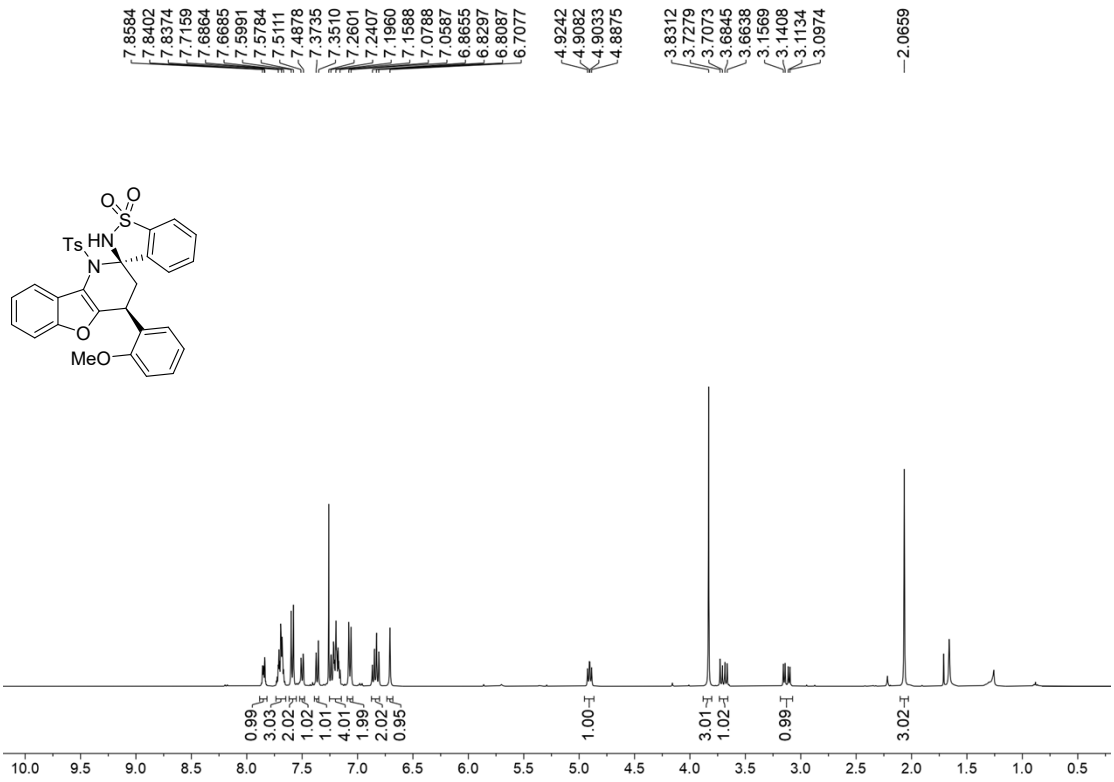
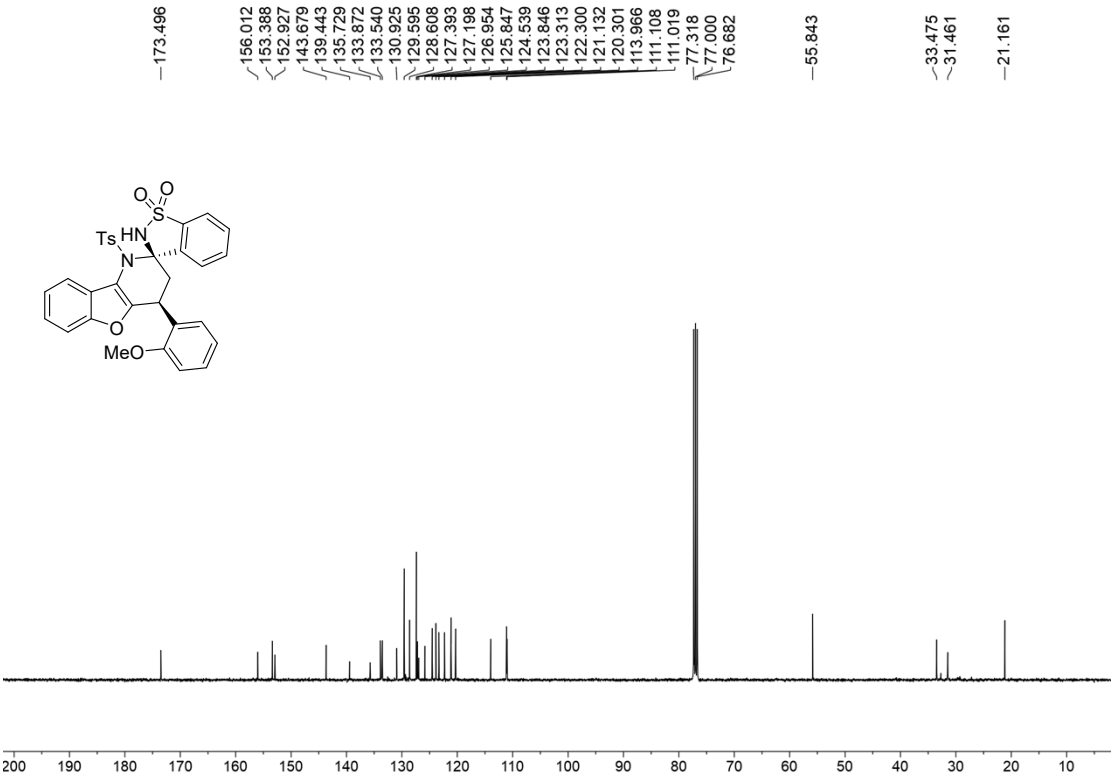
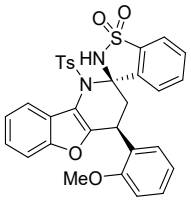
^{1}H NMR of 3ac (400 MHz, $CDCl_3$)

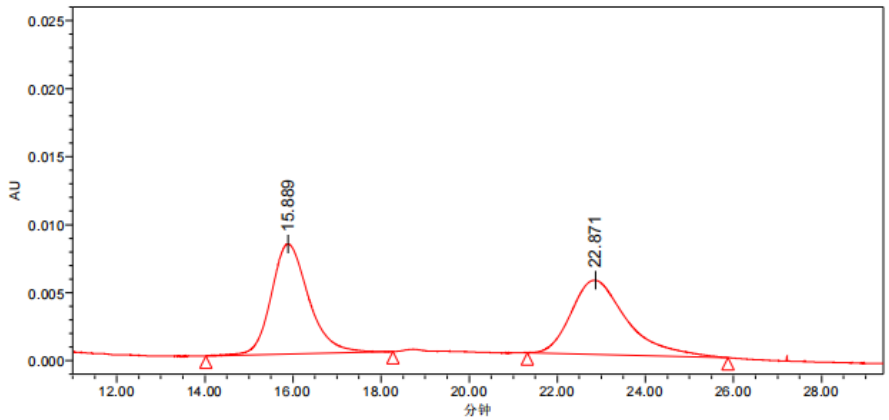


^{13}C NMR of 3ac (101 MHz, $CDCl_3$)

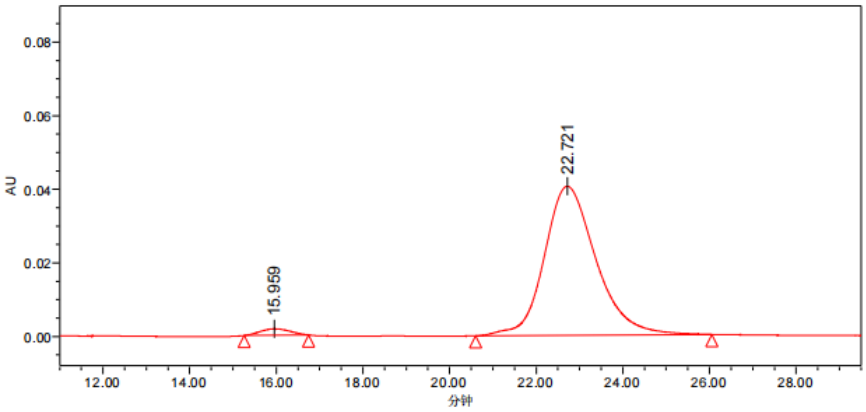


HPLC spectrum of 3ac



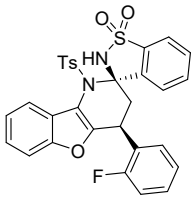


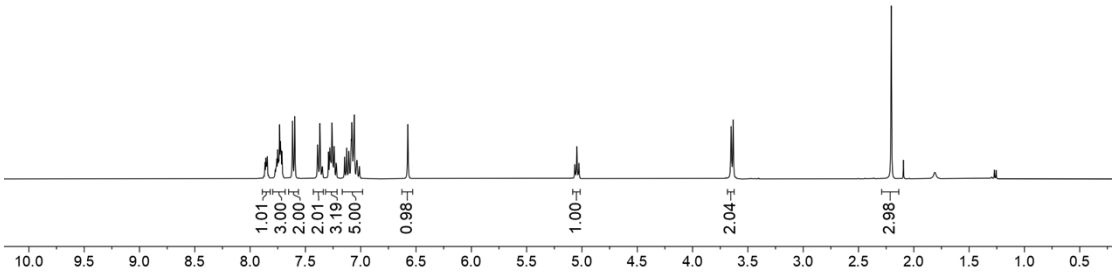
	RetTime [min]	Area [mAU*s]	Area%
1	15.889	477565	50.02
2	22.871	477441	49.98



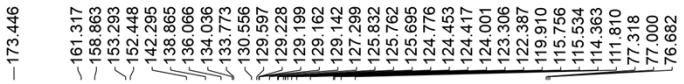
	RetTime [min]	Area [mAU*s]	Area%
1	15.959	82966	2.42
2	22.721	3349426	97.58

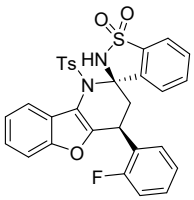
^{1}H NMR of 3ad (400 MHz, $CDCl_3$)

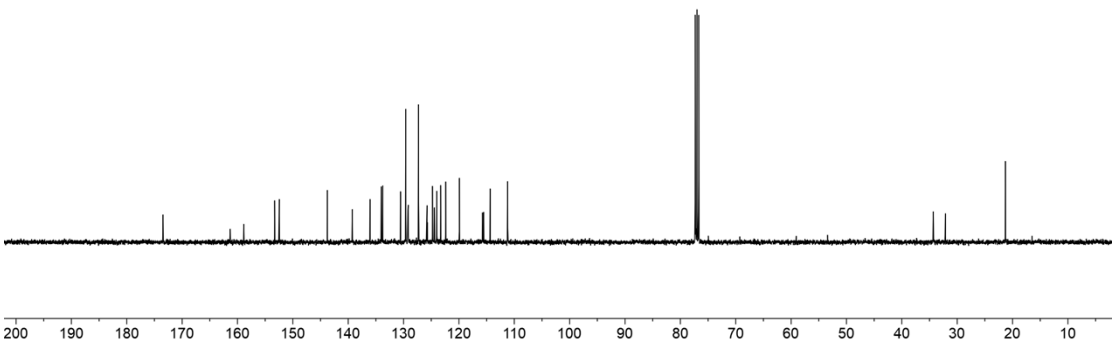




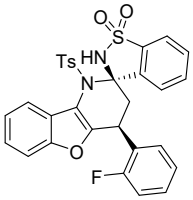
^{13}C NMR of 3ad (101 MHz, $CDCl_3$)

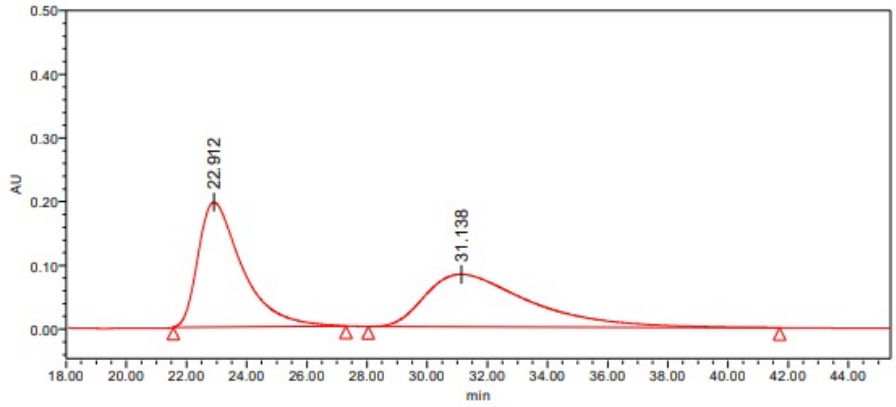




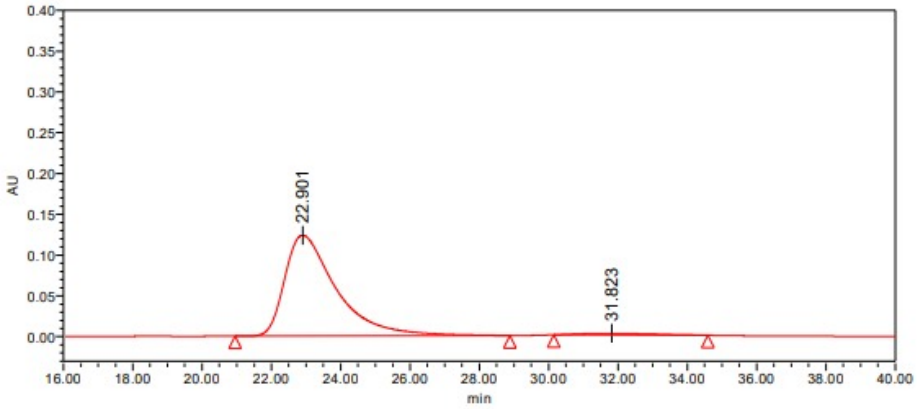


HPLC spectrum of 3ad



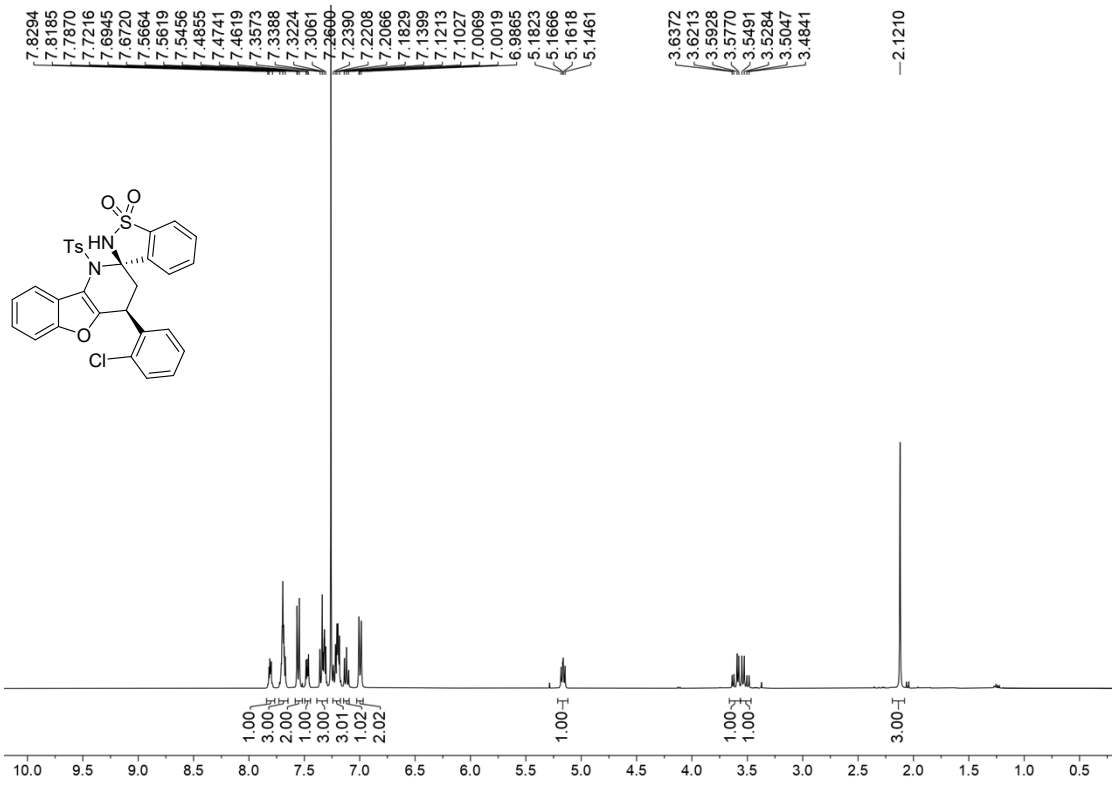


	RetTime [min]	Area [mAU*s]	Area%
1	22.912	19866633	50.00
2	31.138	19863139	50.00

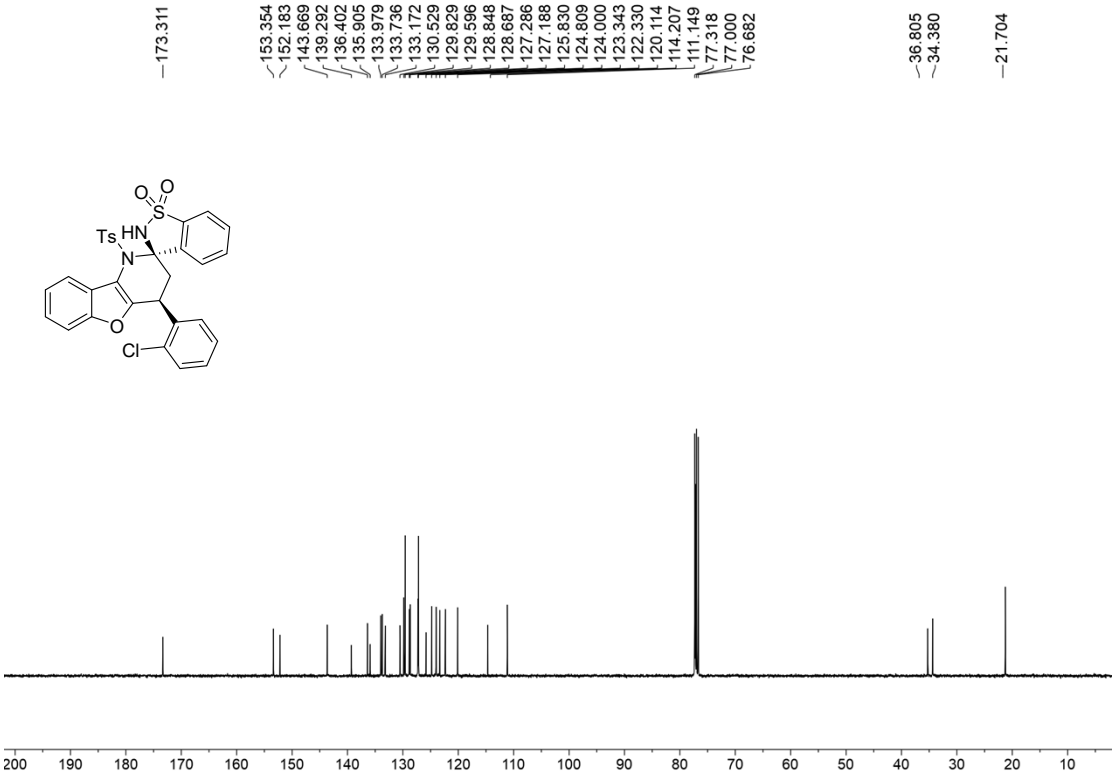


	RetTime [min]	Area [mAU*s]	Area%
1	22.901	12720058	97.69
2	31.823	300984	2.31

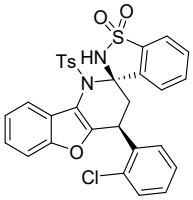
^{1}H NMR of 3ae (400 MHz, $CDCl_3$)

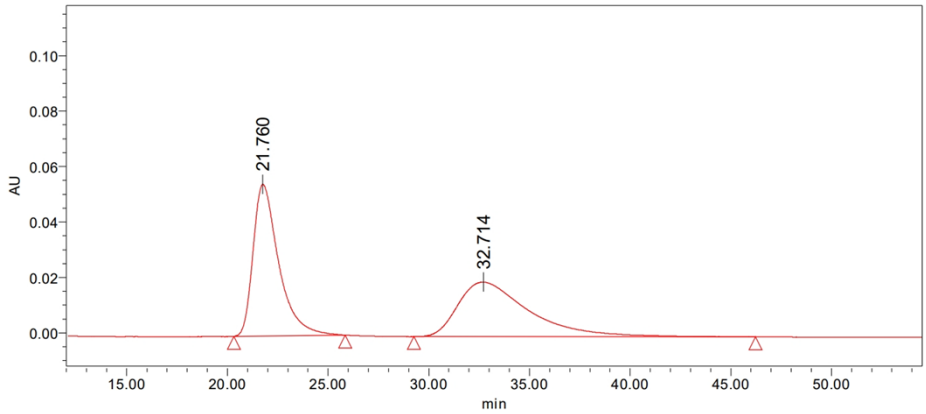


^{13}C NMR of 3ae (101 MHz, $CDCl_3$)

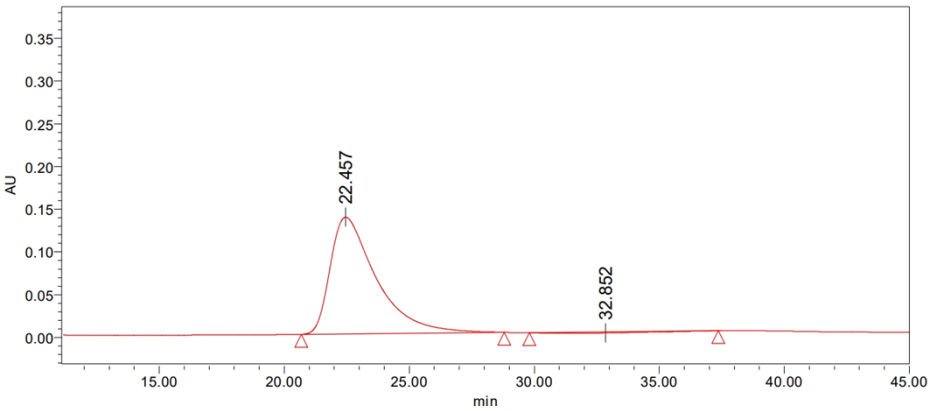


HPLC spectrum of 3ae



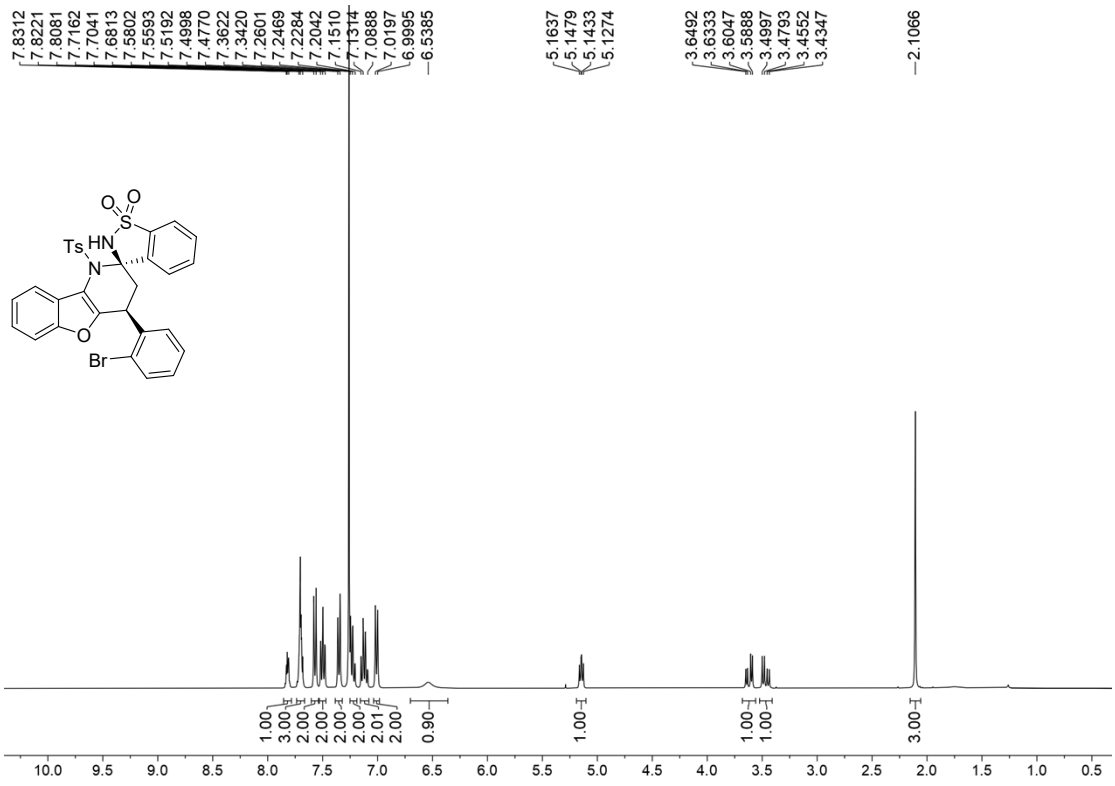


	RetTime [min]	Area [mAU*s]	Area%
1	21.760	4835549	50.03
2	32.714	4830356	49.97

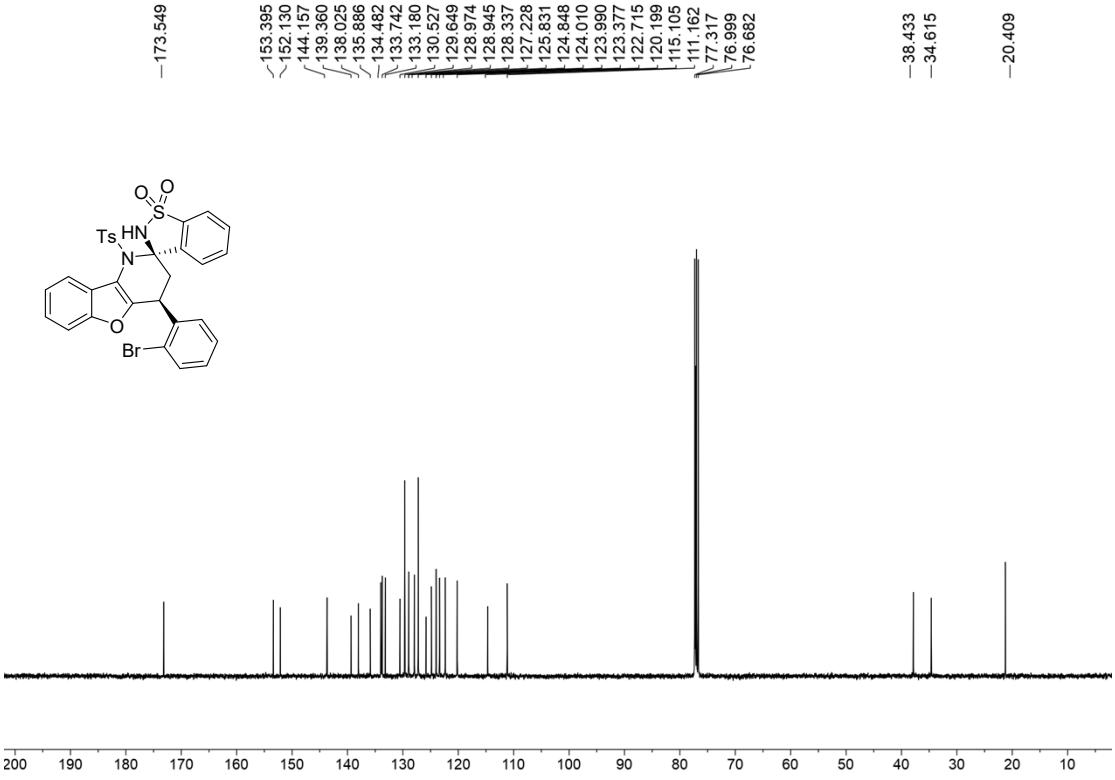


	RetTime [min]	Area [mAU*s]	Area%
1	22.457	17501866	98.45
2	32.852	275975	1.55

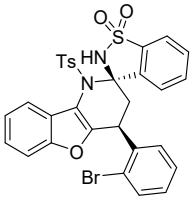
^{1}H NMR of 3af (400 MHz, $CDCl_3$)

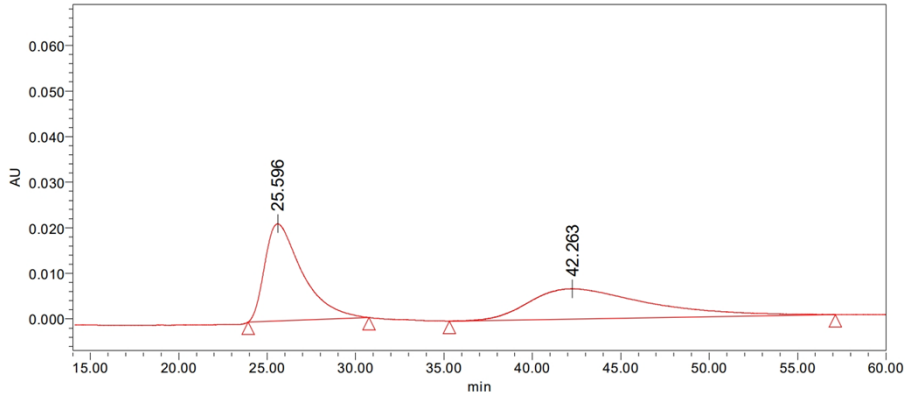


^{13}C NMR of 3af (101 MHz, $CDCl_3$)

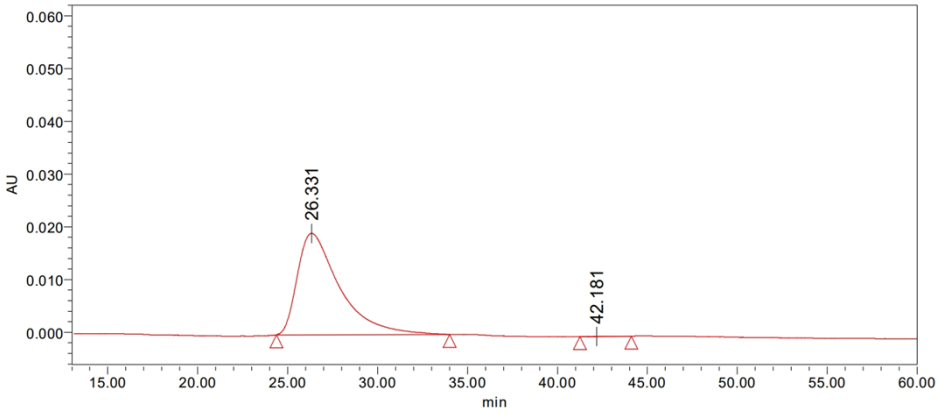


HPLC spectrum of 3af



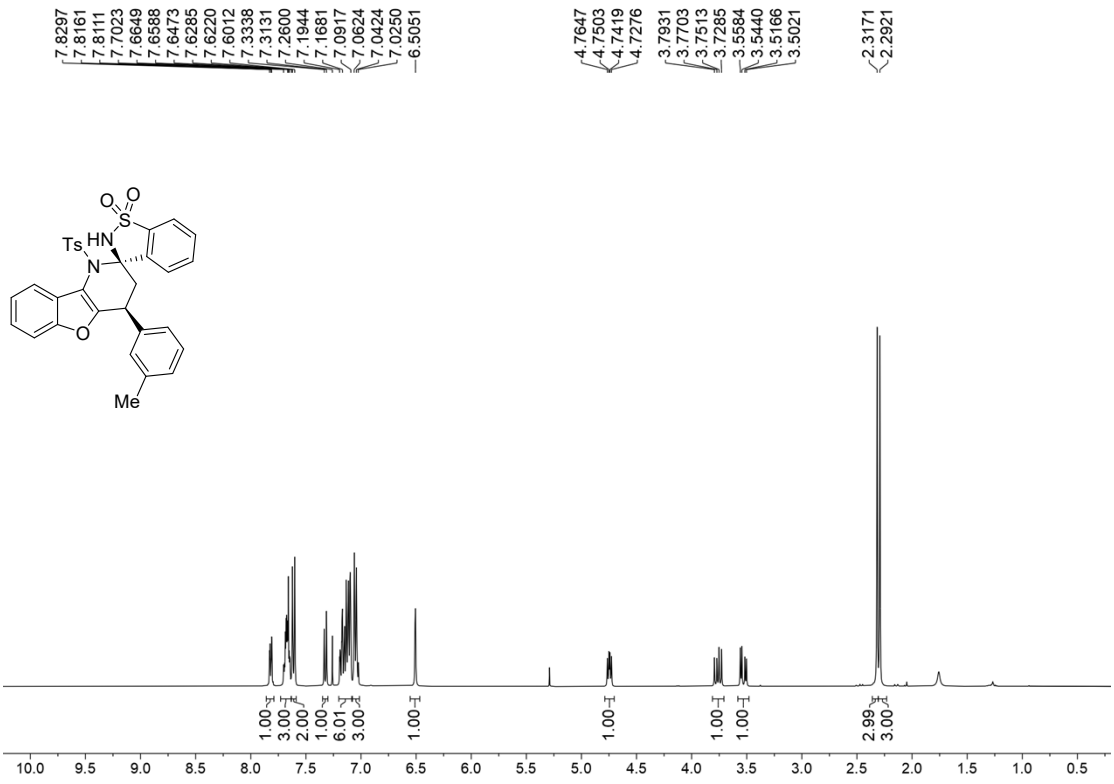


	RetTime [min]	Area [mAU*s]	Area%
1	25.596	3143247	50.44
2	42.263	3087967	49.56

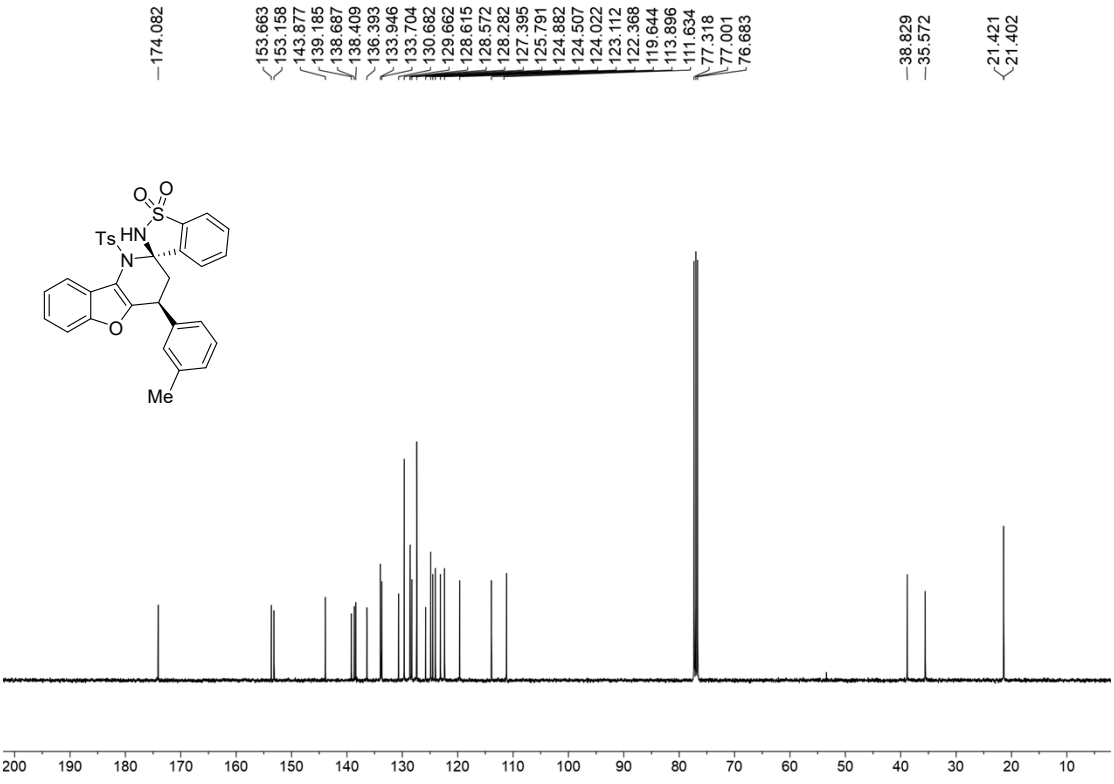


	RetTime [min]	Area [mAU*s]	Area%
1	26.331	3541998	99.96
2	42.181	189736	0.04

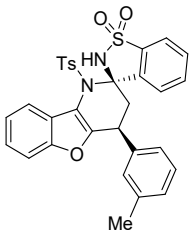
^{1}H NMR of 3ag (400 MHz, $CDCl_3$)

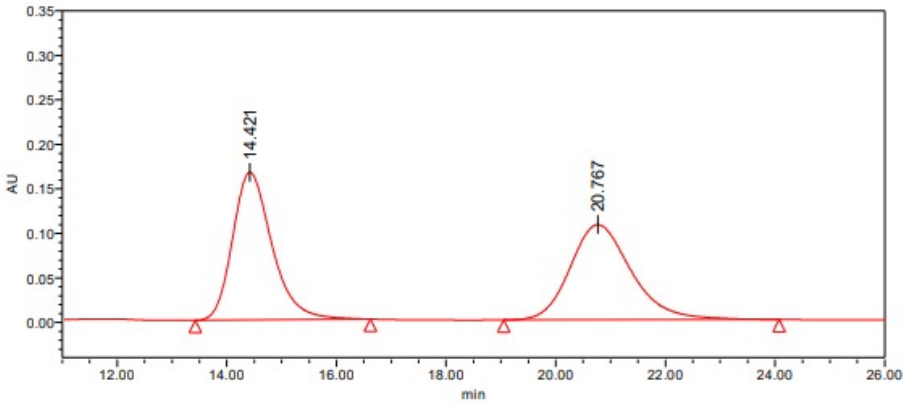


^{13}C NMR of 3ag (101 MHz, $CDCl_3$)

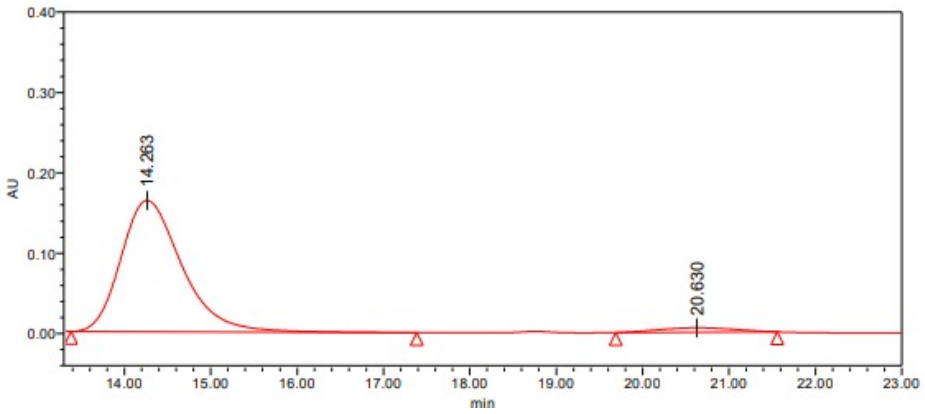


HPLC spectrum of 3ag



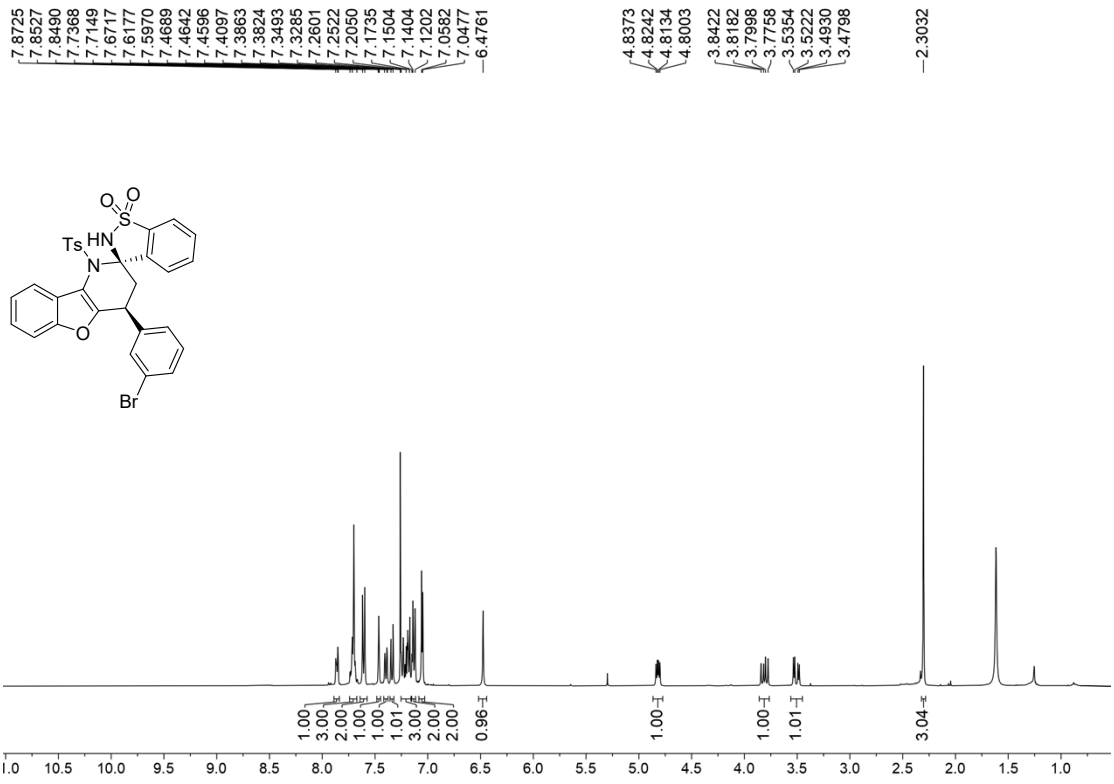


	RetTime [min]	Area [mAU*s]	Area%
1	14.421	8288901	50.00
2	20.767	8288043	50.00

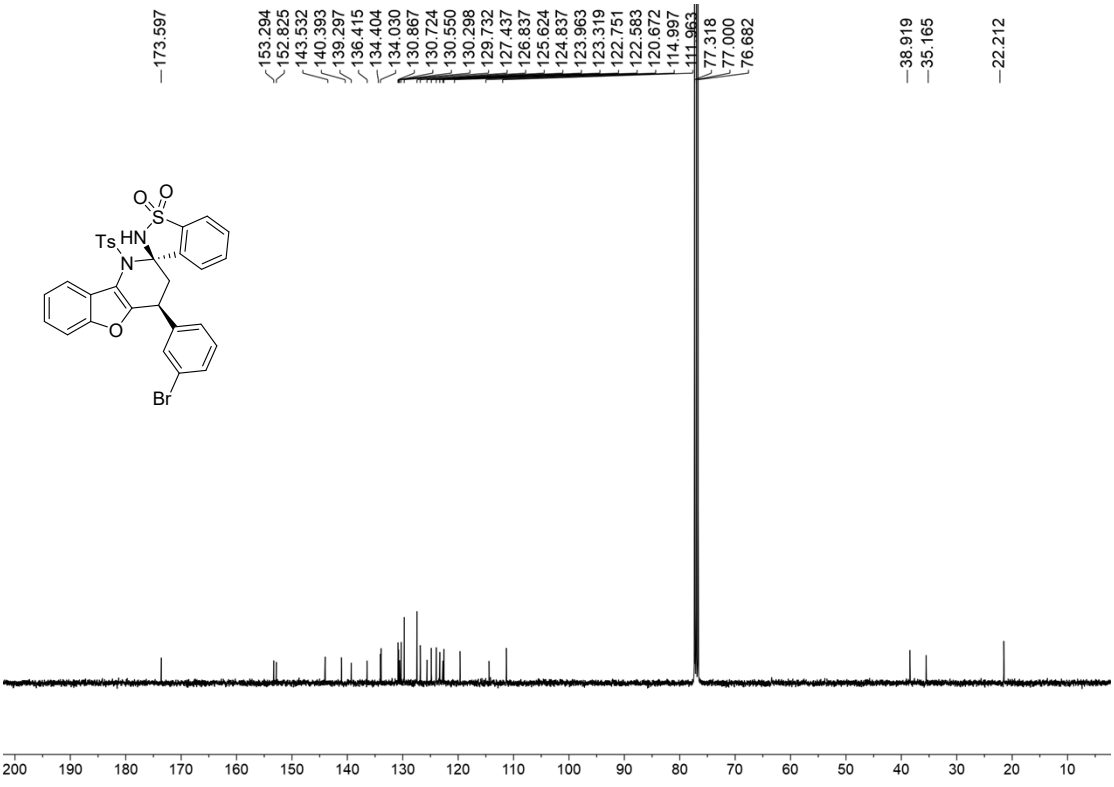


	RetTime [min]	Area [mAU*s]	Area%
1	14.263	7987879	96.01
2	20.630	331625	3.99

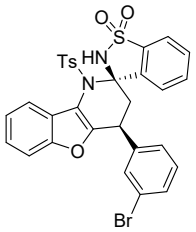
^{1}H NMR of 3ah (400 MHz, $CDCl_3$)

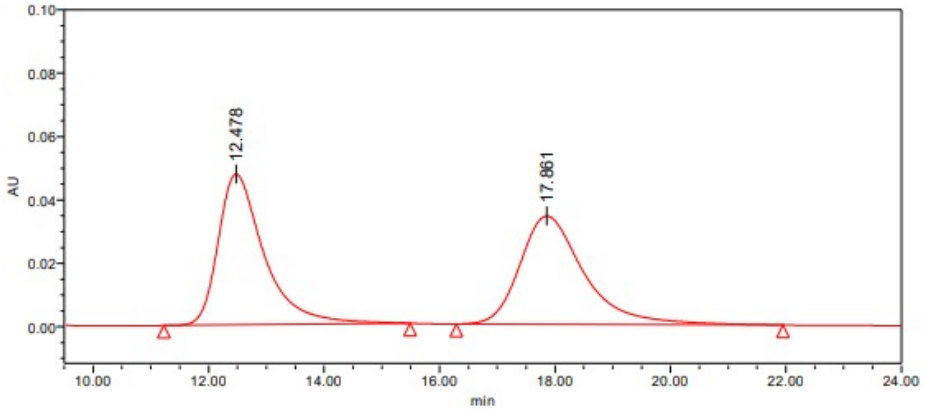


^{13}C NMR of 3ah (101 MHz, $CDCl_3$)

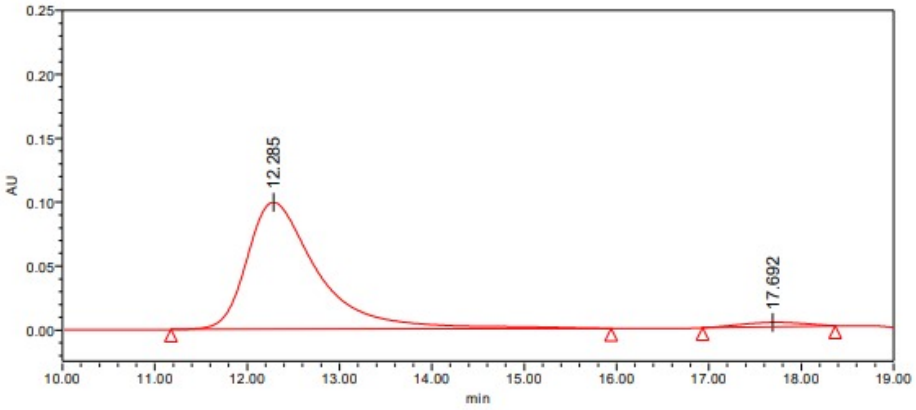


HPLC spectrum of 3ah



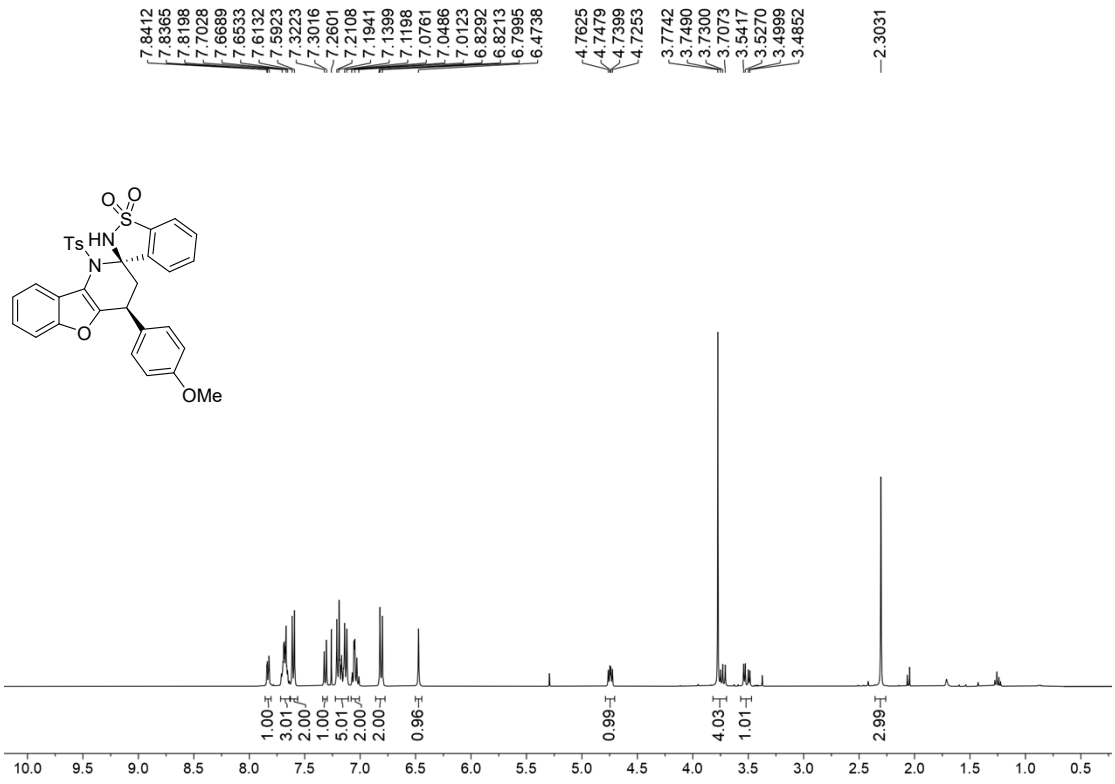


	RetTime [min]	Area [mAU*s]	Area%
1	12.478	2640598	50.00
2	17.861	2640320	50.00

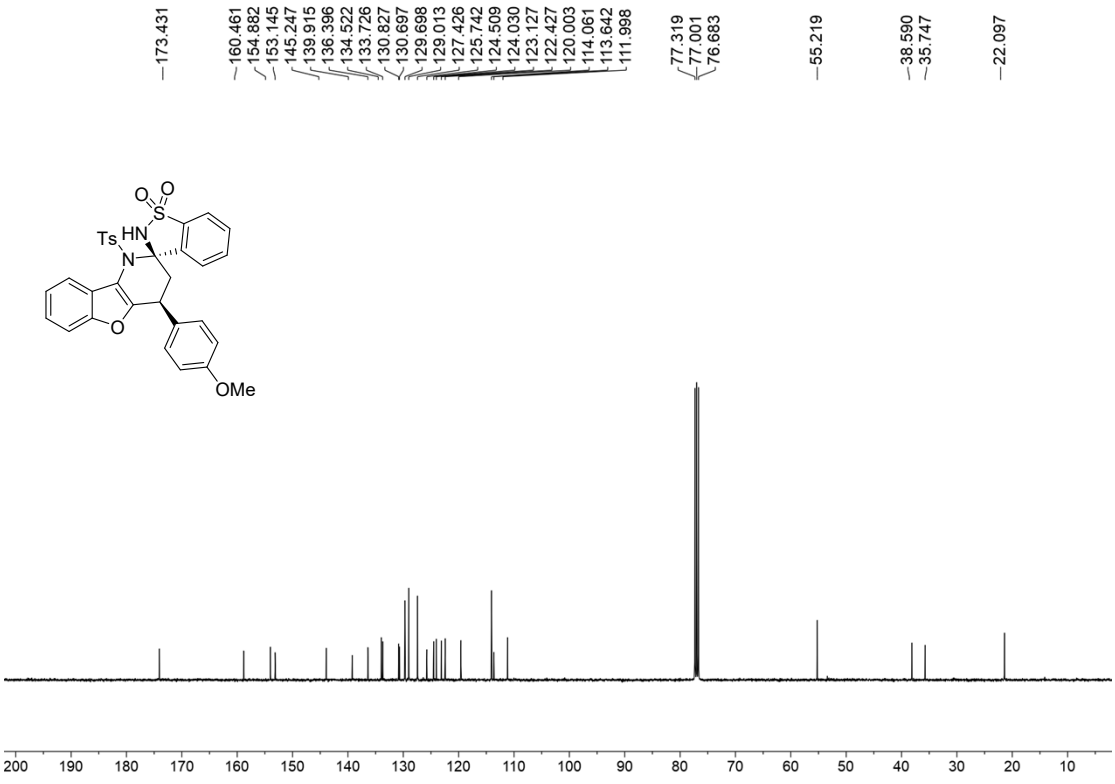


	RetTime [min]	Area [mAU*s]	Area%
1	12.285	5316661	97.02
2	17.692	163524	2.98

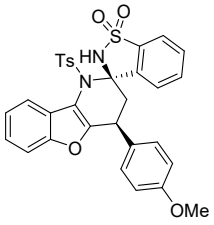
^{1}H NMR of 3ai (400 MHz, $CDCl_3$)

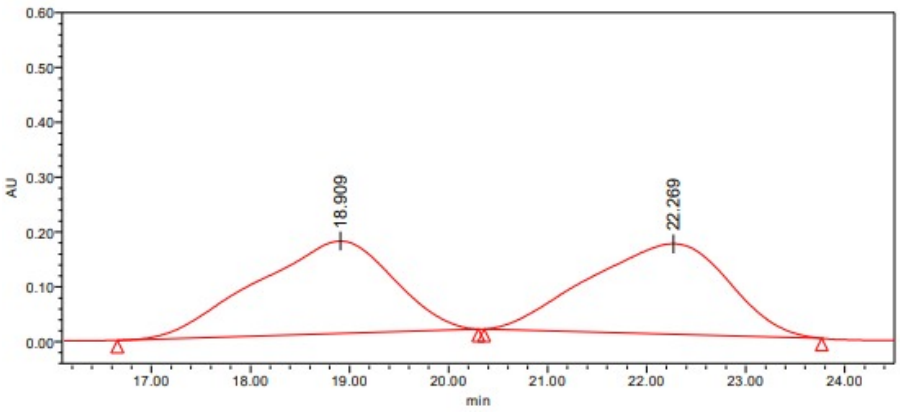


^{13}C NMR of 3ai (101 MHz, $CDCl_3$)

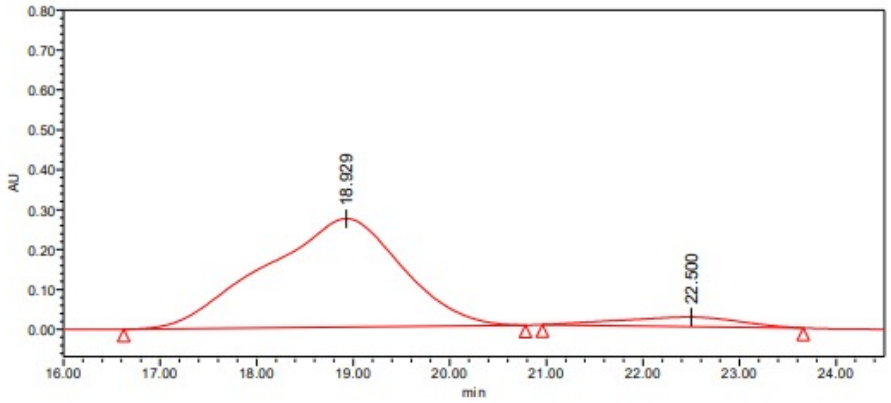


HPLC spectrum of 3ai



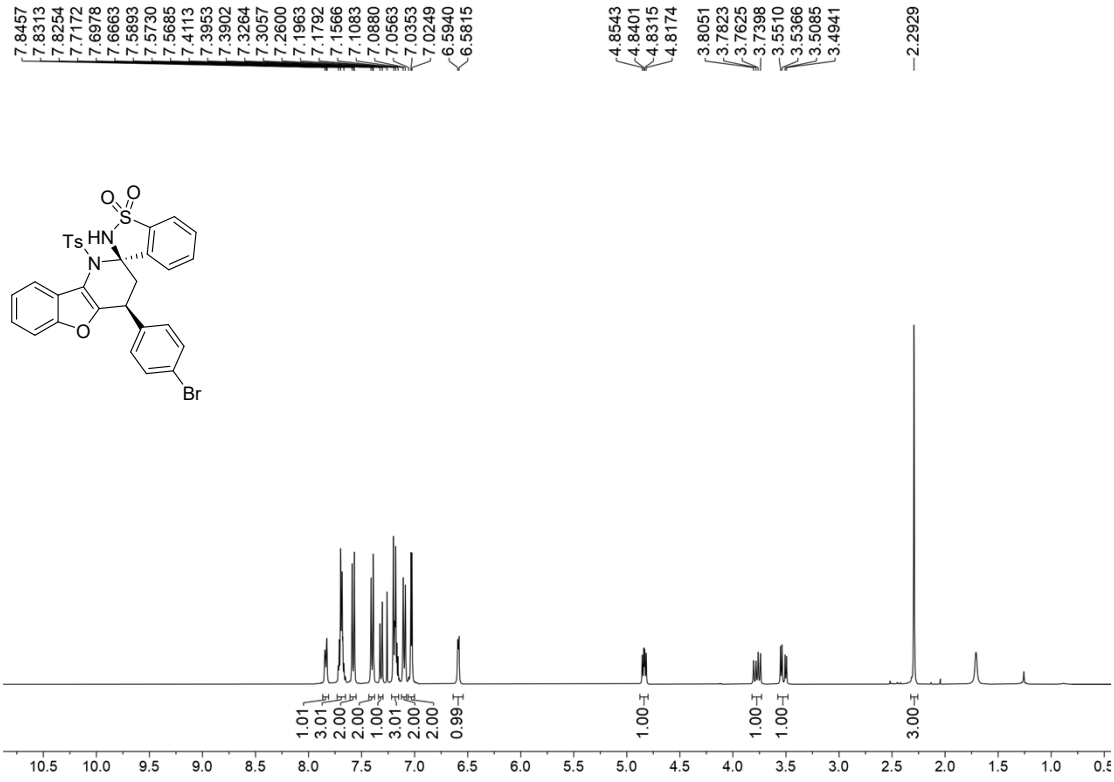


	RetTime [min]	Area [mAU*s]	Area%
1	18.909	16168923	50.00
2	22.269	16171302	50.00

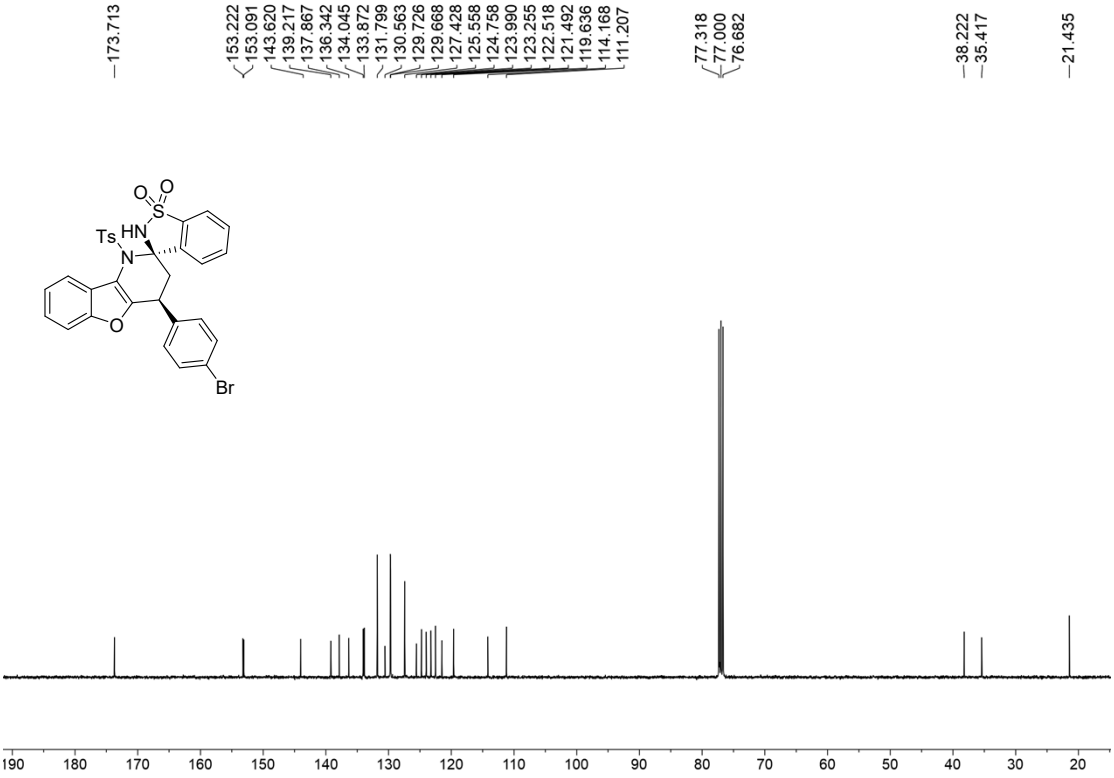


	RetTime [min]	Area [mAU*s]	Area%
1	18.929	26643471	93.00
2	22.500	2005887	7.00

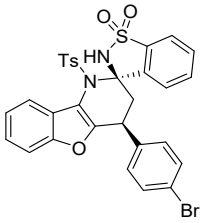
^{1}H NMR of 3aj (400 MHz, $CDCl_3$)

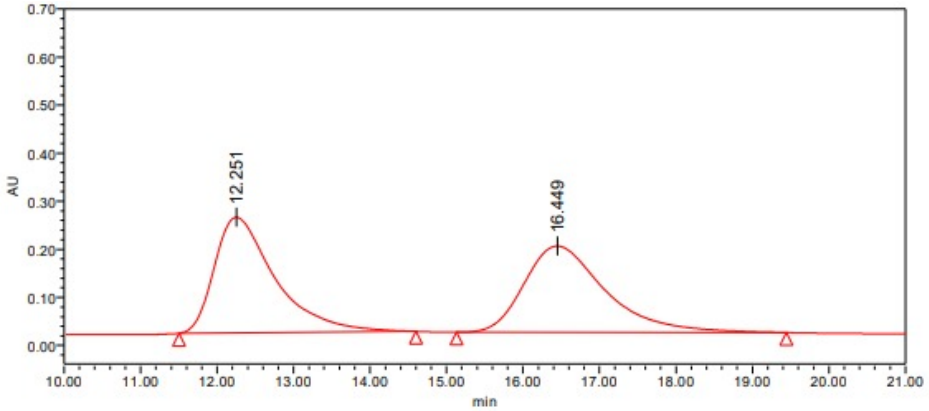


^{13}C NMR of 3aj (101 MHz, $CDCl_3$)

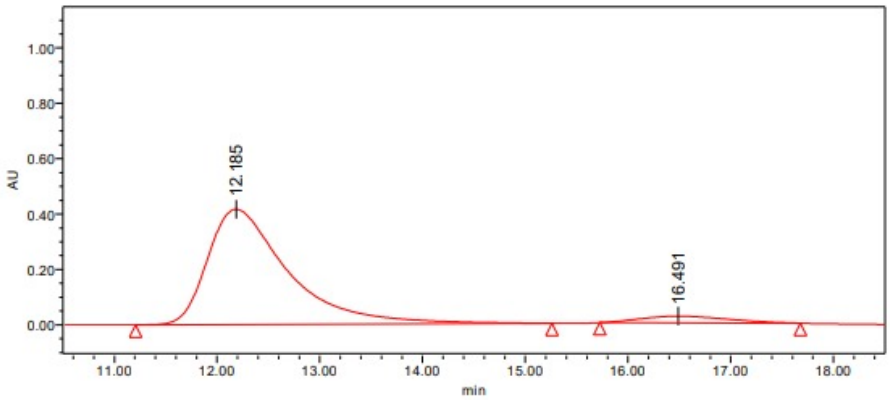


HPLC spectrum of 3aj



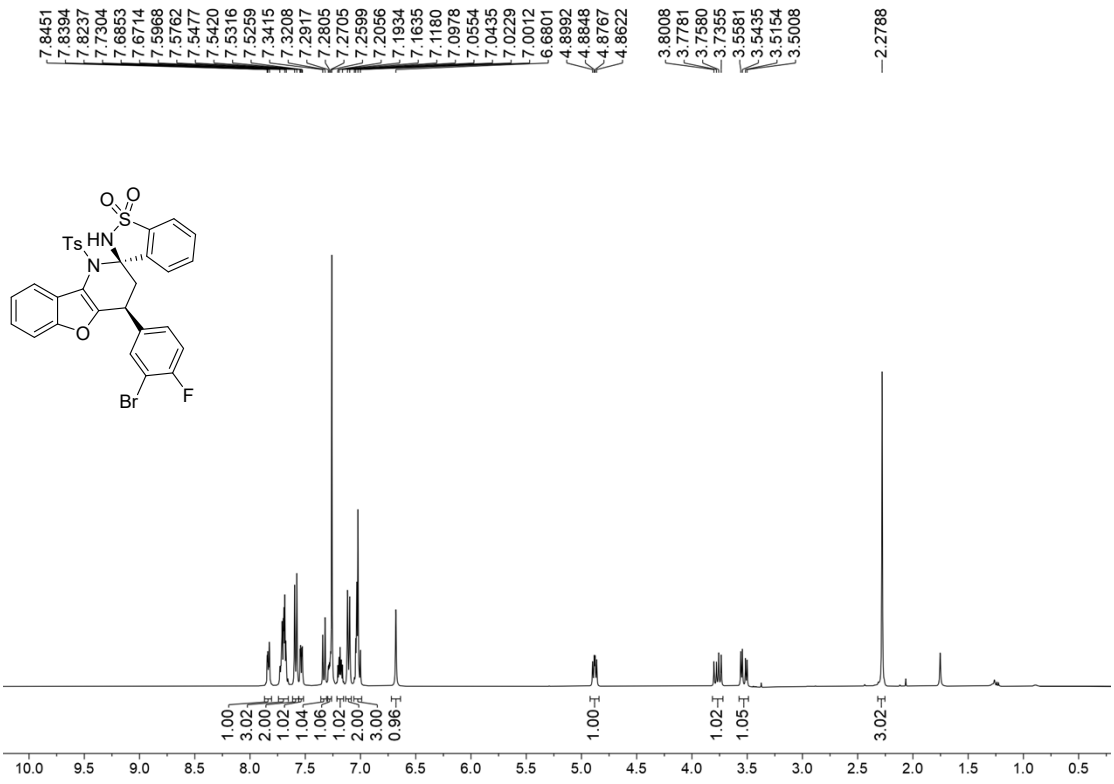


	RetTime [min]	Area [mAU*s]	Area%
1	12.251	13237264	50.00
2	16.449	13237100	50.00

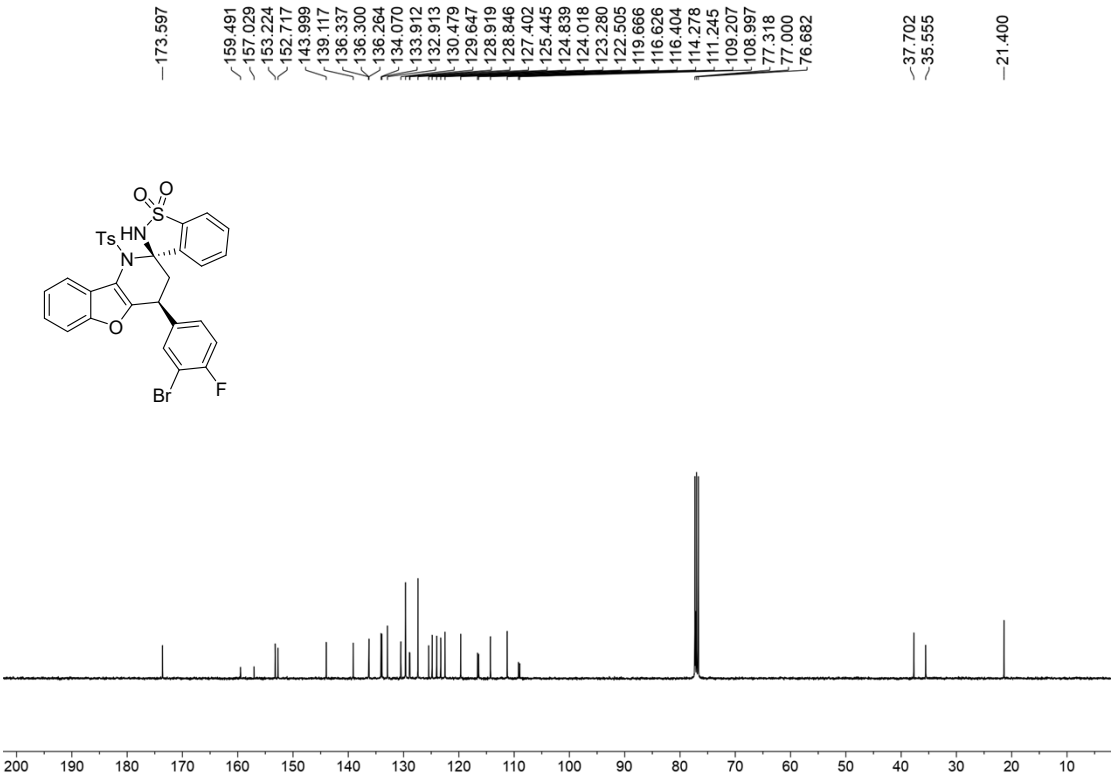


	RetTime [min]	Area [mAU*s]	Area%
1	12.185	8090618	95.09
2	16.491	417364	4.91

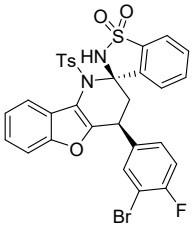
^{1}H NMR of 3ak (400 MHz, $CDCl_3$)

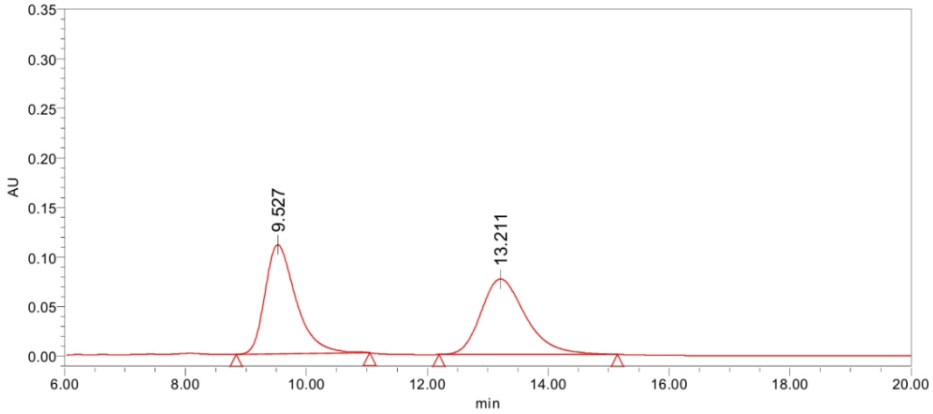


^{13}C NMR of 3ak (101 MHz, $CDCl_3$)

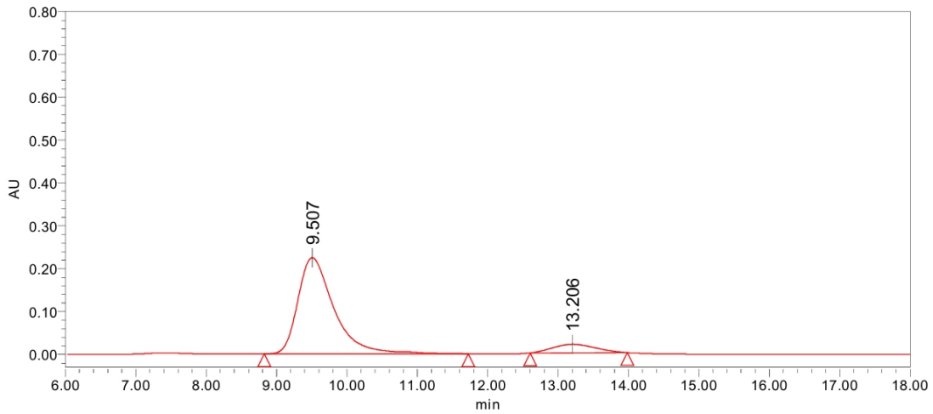


HPLC spectrum of 3ak



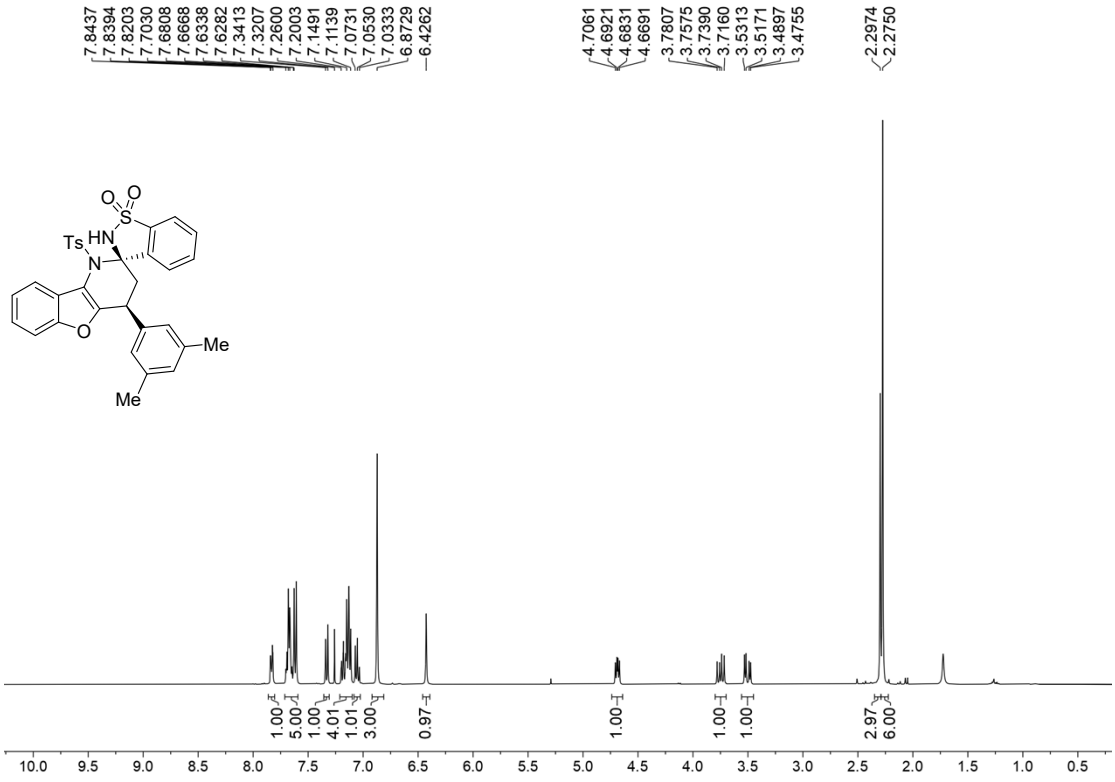


	RetTime [min]	Area [mAU*s]	Area%
1	9.527	3922127	50.00
2	13.211	3922773	50.00

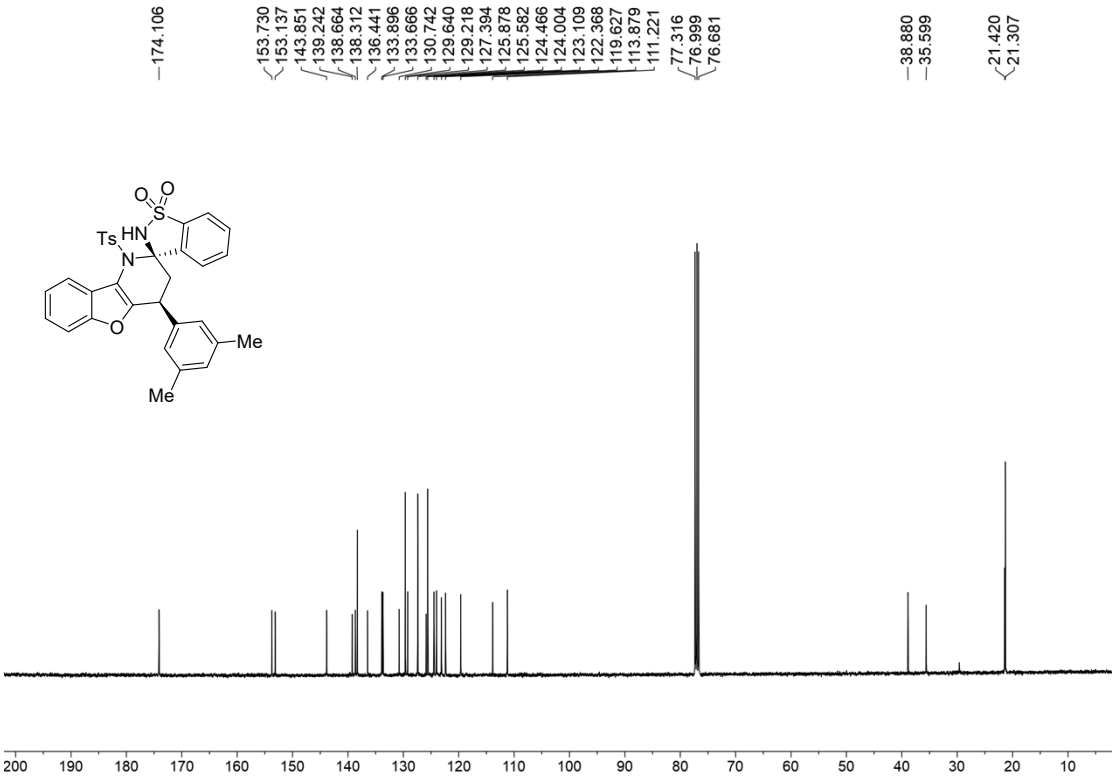


	RetTime [min]	Area [mAU*s]	Area%
1	9.507	7974390	90.52
2	13.206	835507	9.48

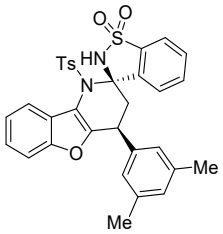
^{1}H NMR of 3al (400 MHz, $CDCl_3$)

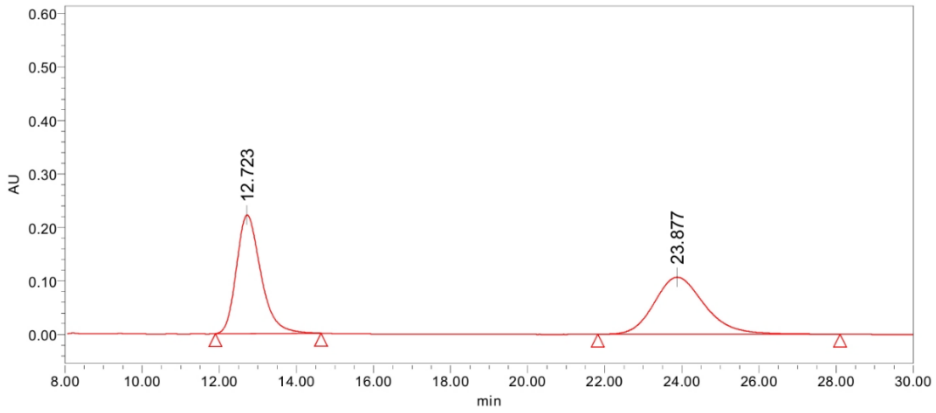


^{13}C NMR of 3al (101 MHz, $CDCl_3$)

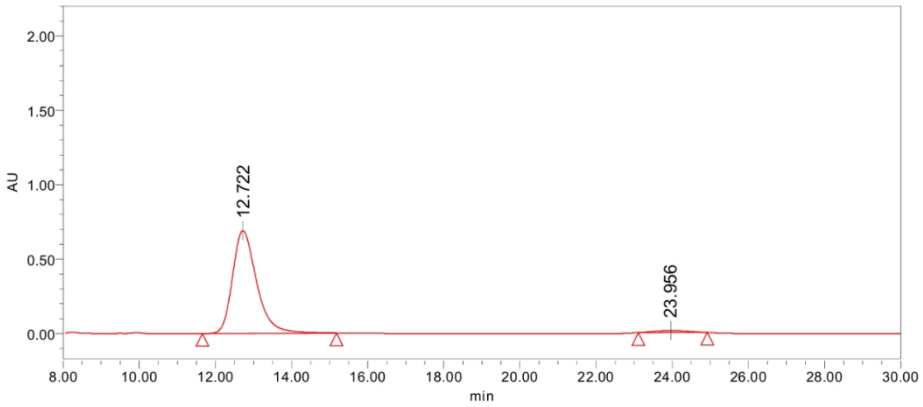


HPLC spectrum of 3al



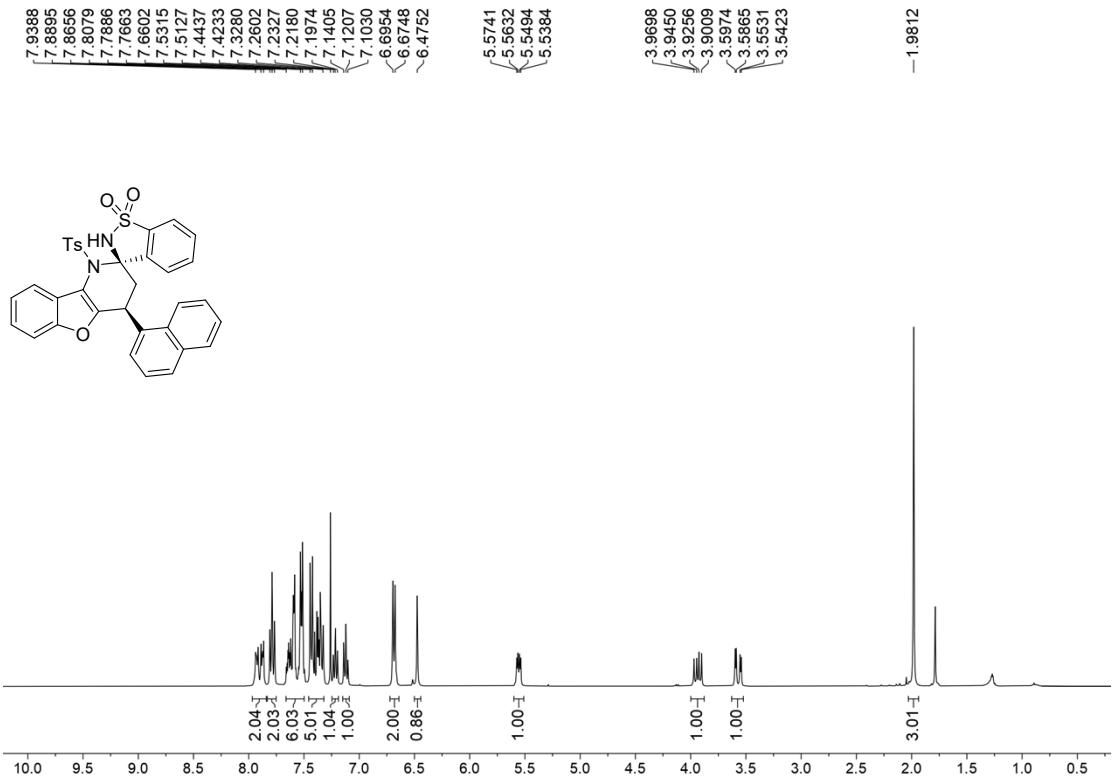


	RetTime [min]	Area [mAU*s]	Area%
1	12.723	9718309	50.00
2	23.877	9720076	50.00

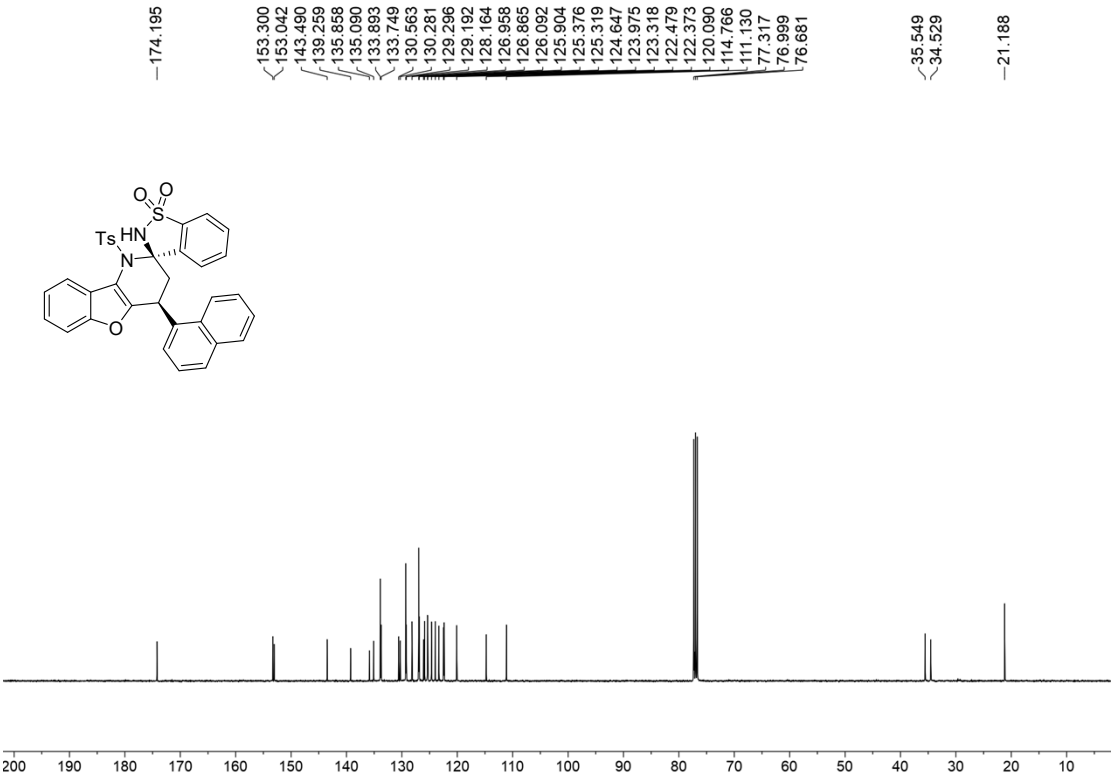


	RetTime [min]	Area [mAU*s]	Area%
1	12.722	30187364	97.15
2	23.956	885149	2.85

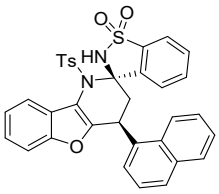
^{1}H NMR of 3am (400 MHz, $CDCl_3$)

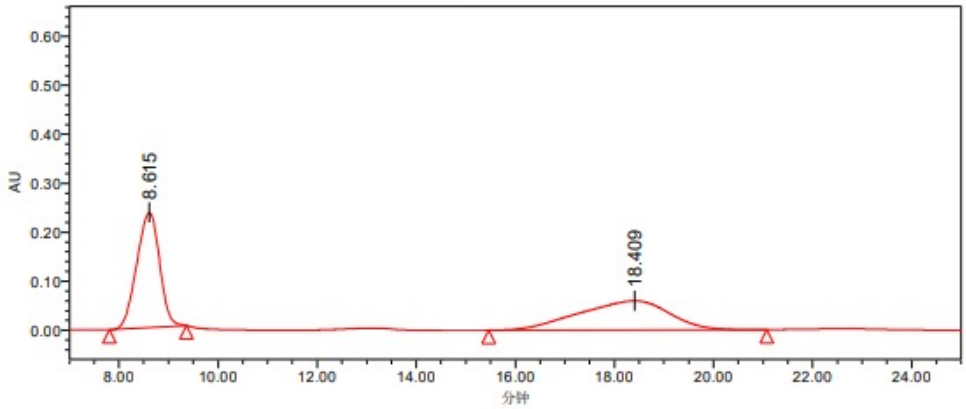


^{13}C NMR of 3am (101 MHz, $CDCl_3$)

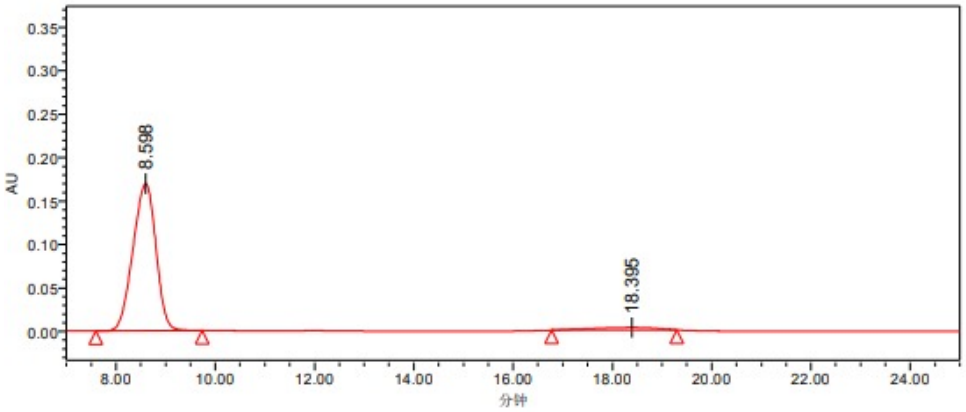


HPLC spectrum of 3am



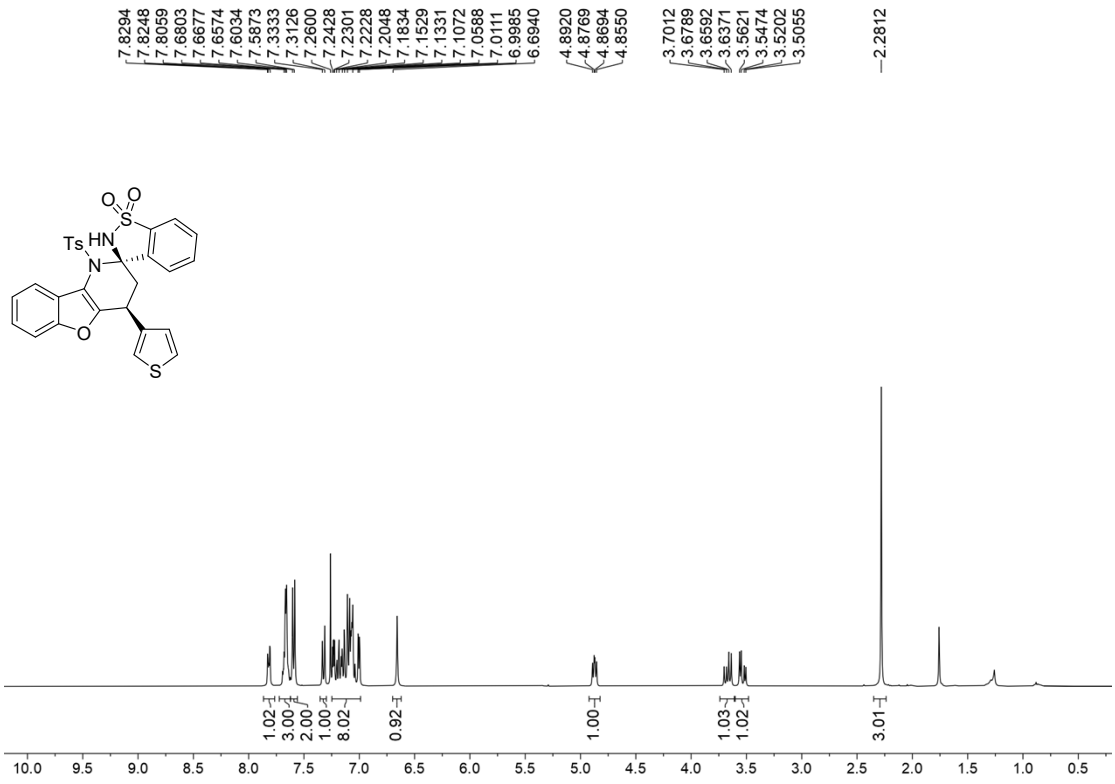


	RetTime [min]	Area [mAU*s]	Area%
1	8.615	7514605	50.02
2	18.409	7509655	49.98

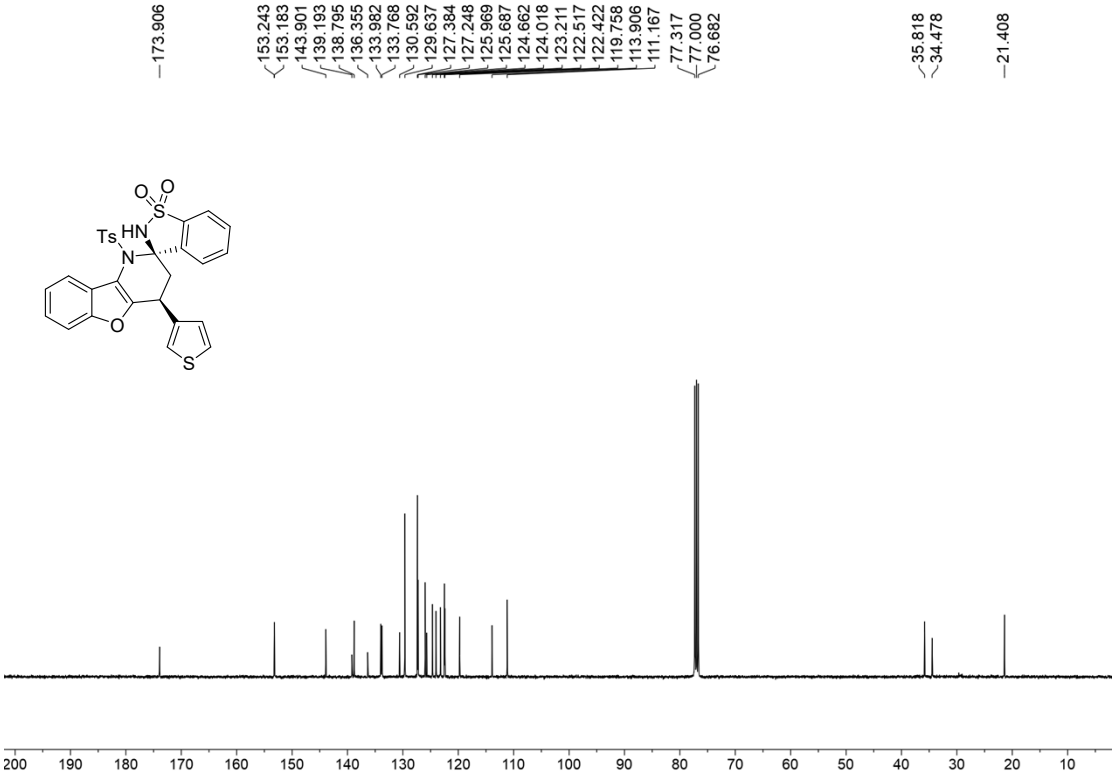


	RetTime [min]	Area [mAU*s]	Area%
1	8.598	5424695	95.51
2	18.395	255214	4.49

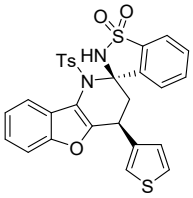
^{1}H NMR of 3an (400 MHz, $CDCl_3$)

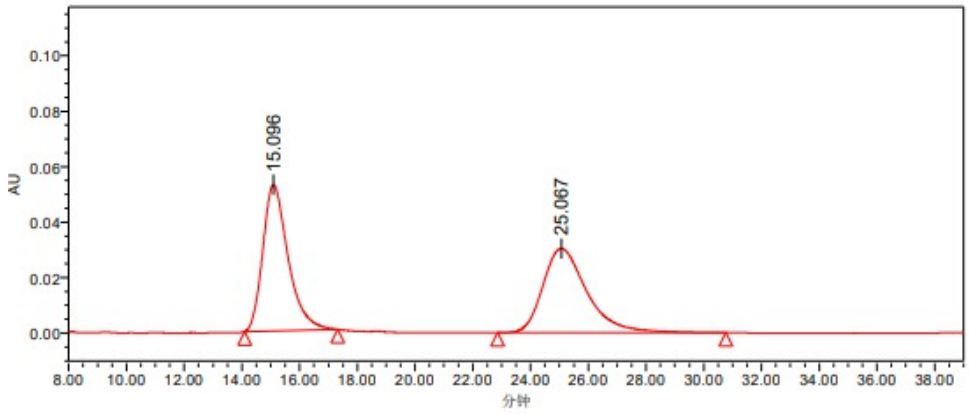


^{13}C NMR of 3an (101 MHz, $CDCl_3$)

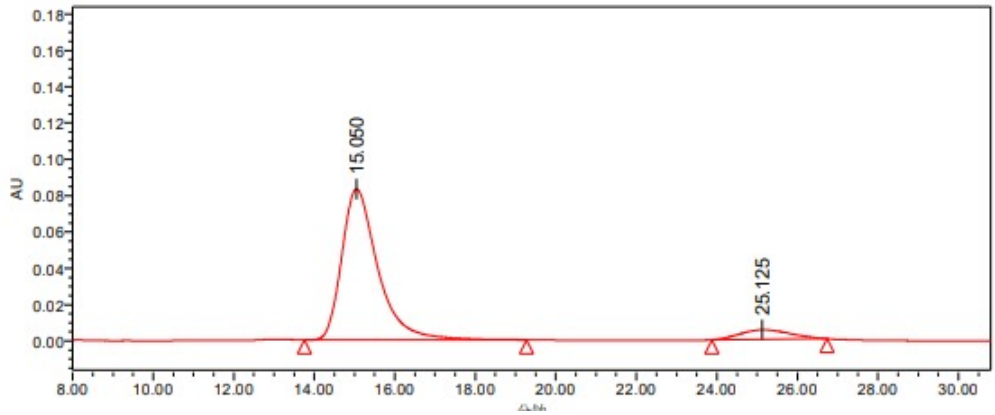


HPLC spectrum of 3an



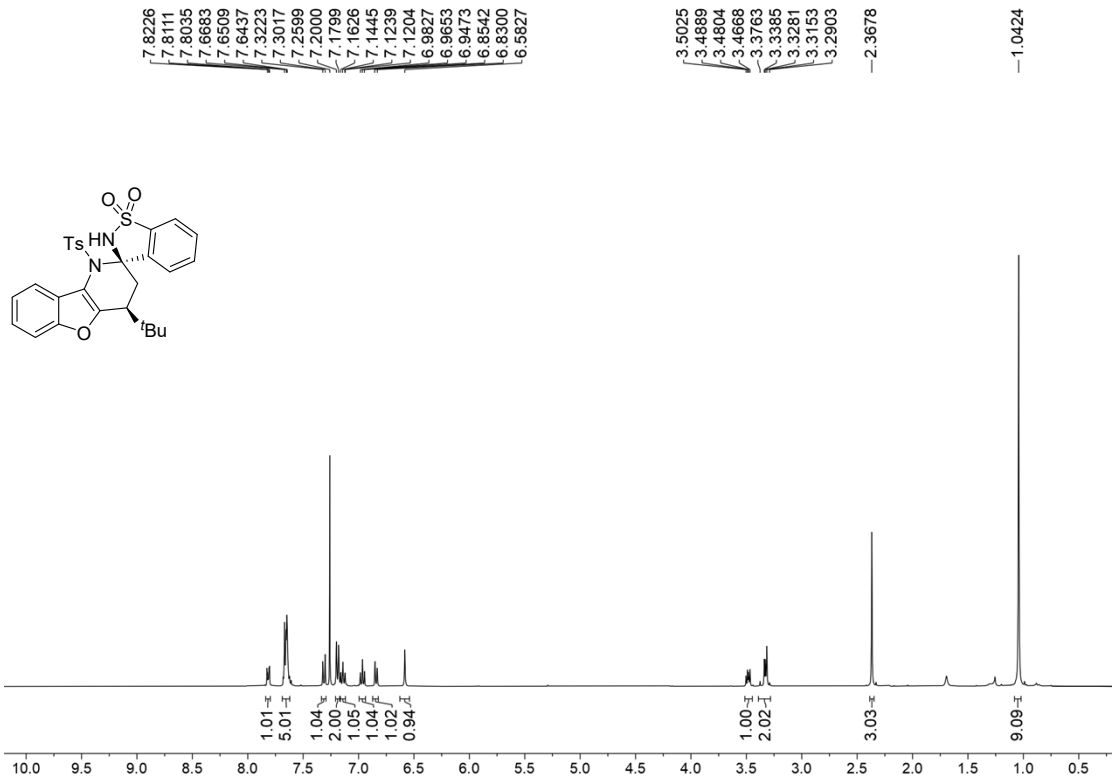


	RetTime [min]	Area [mAU*s]	Area%
1	15.096	3221511	50.03
2	25.067	3217397	49.97

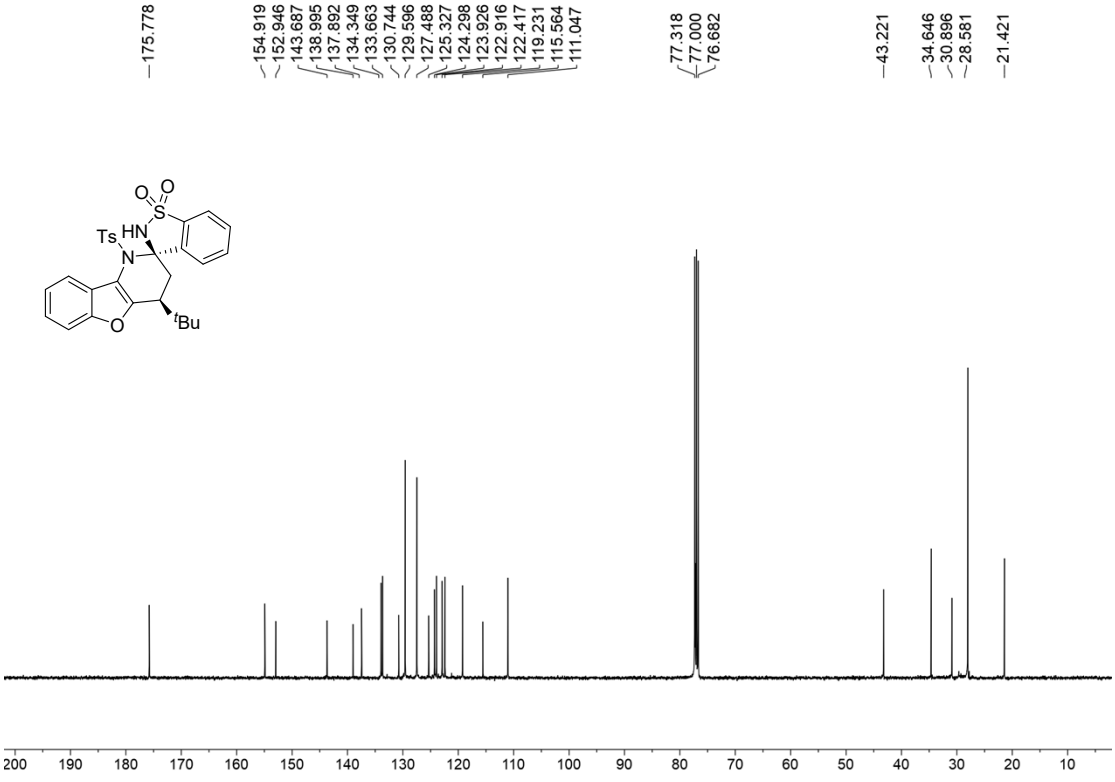


	RetTime [min]	Area [mAU*s]	Area%
1	15.050	5188964	91.94
2	25.125	454755	8.06

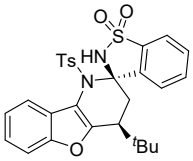
^{1}H NMR of 3ao (400 MHz, $CDCl_3$)

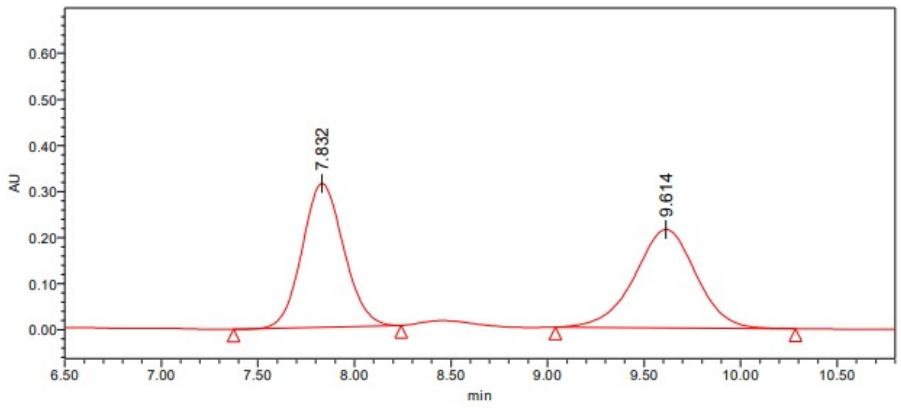


^{13}C NMR of 3ao (101 MHz, $CDCl_3$)

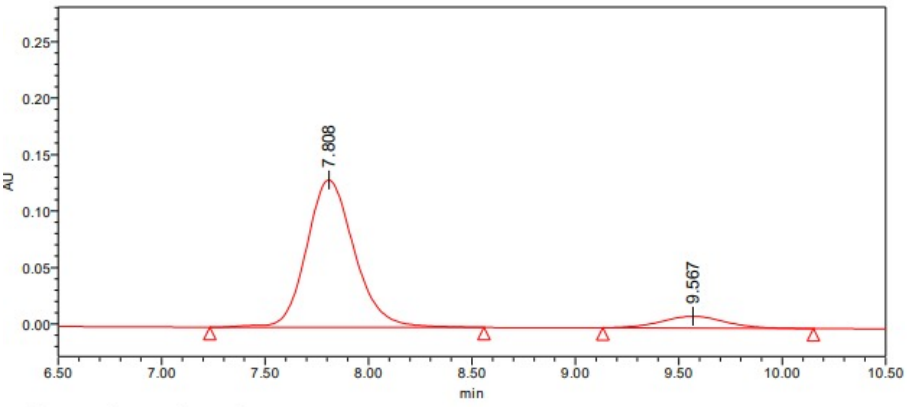


HPLC spectrum of 3ao



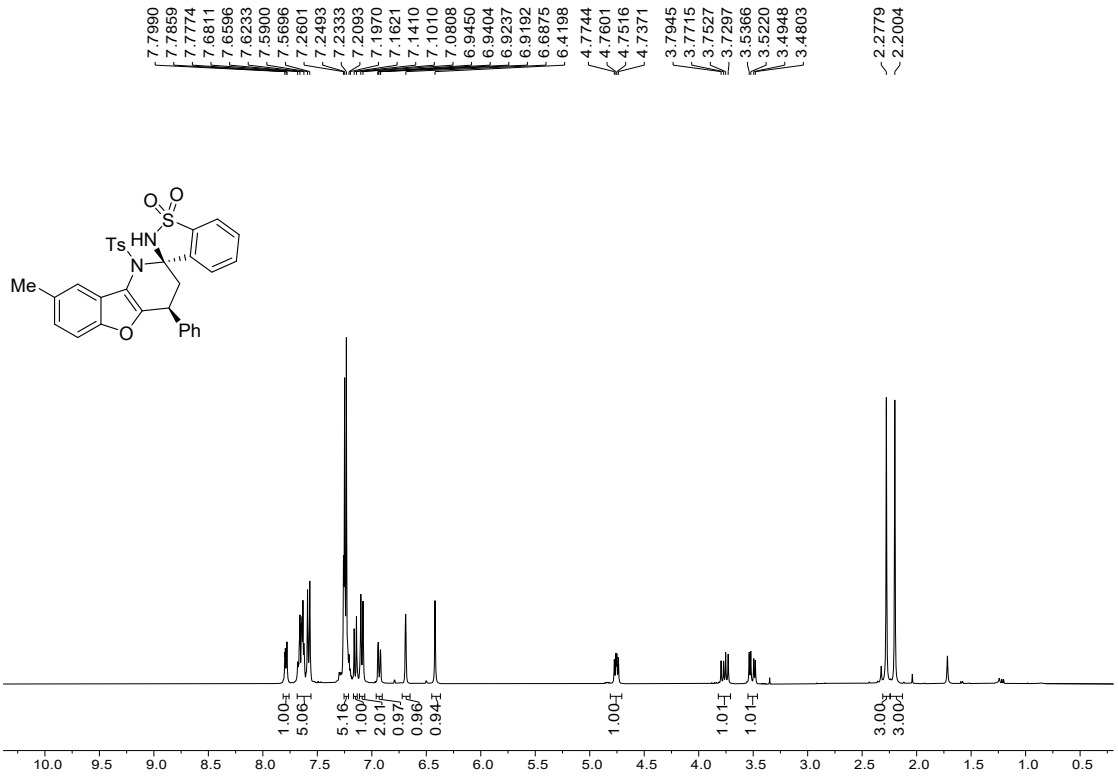


	RetTime [min]	Area [mAU*s]	Area%
1	7.832	4679628	49.74
2	9.614	4729482	50.26

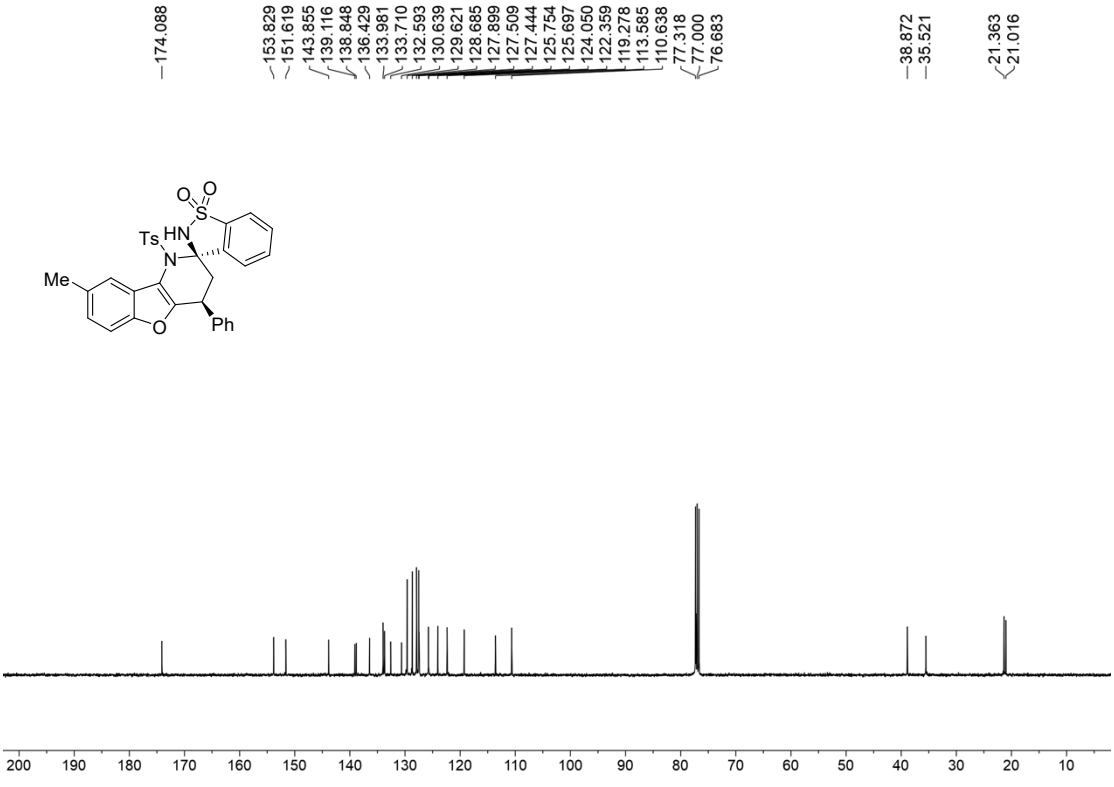


	RetTime [min]	Area [mAU*s]	Area%
1	7.808	2099583	90.37
2	9.567	223755	9.63

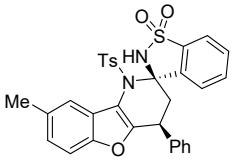
^{1}H NMR of 3ba (400 MHz, $CDCl_3$)

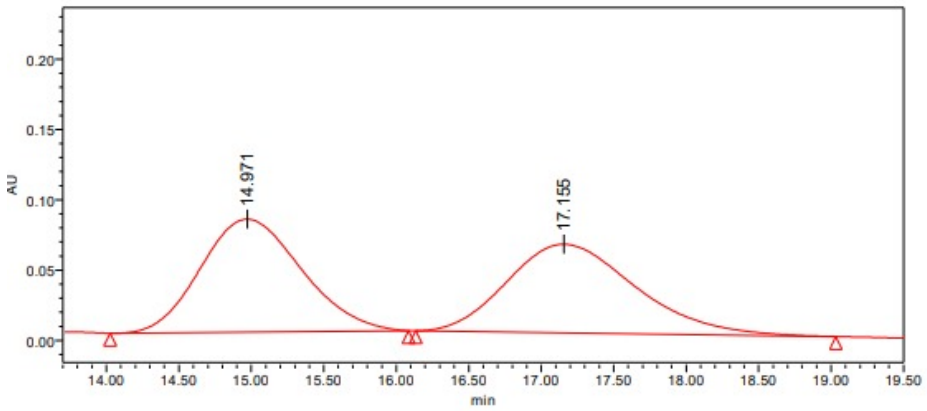


^{13}C NMR of 3ba (101 MHz, $CDCl_3$)

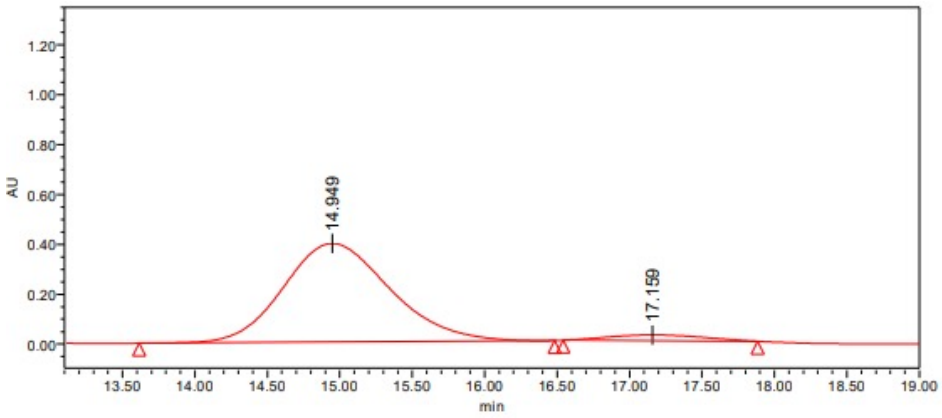


HPLC spectrum of 3ba



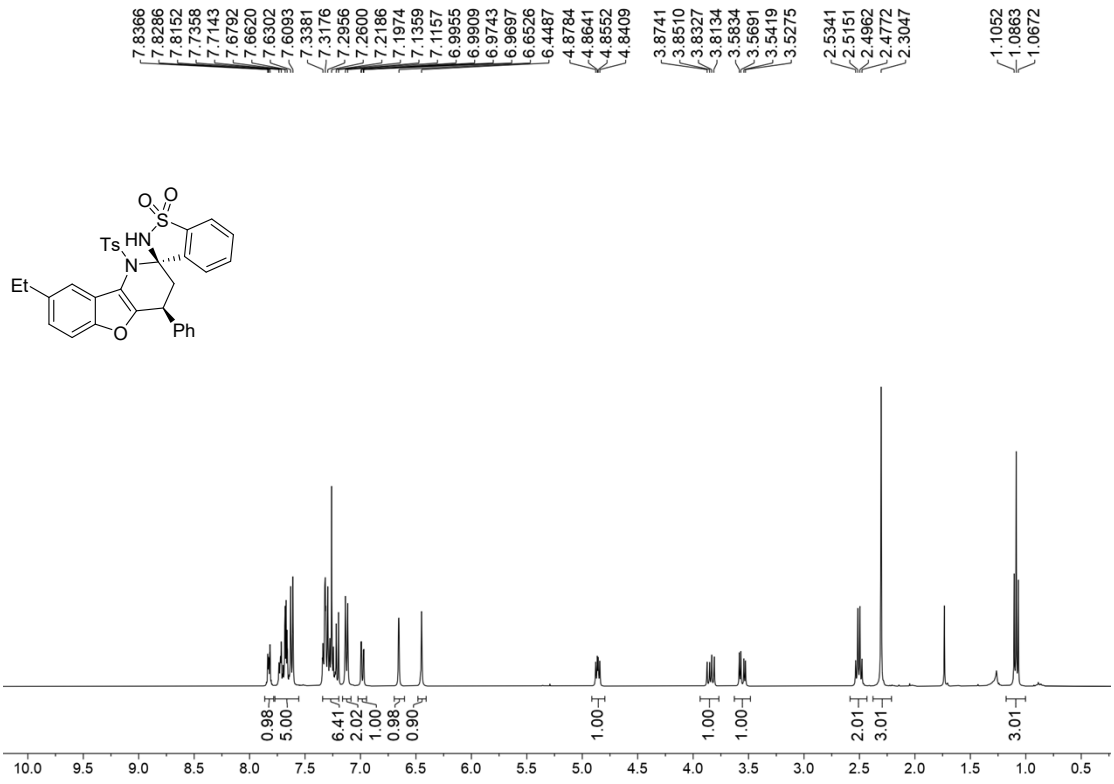


	RetTime [min]	Area [mAU*s]	Area%
1	14.971	3883946	50.01
2	17.155	3881770	49.99

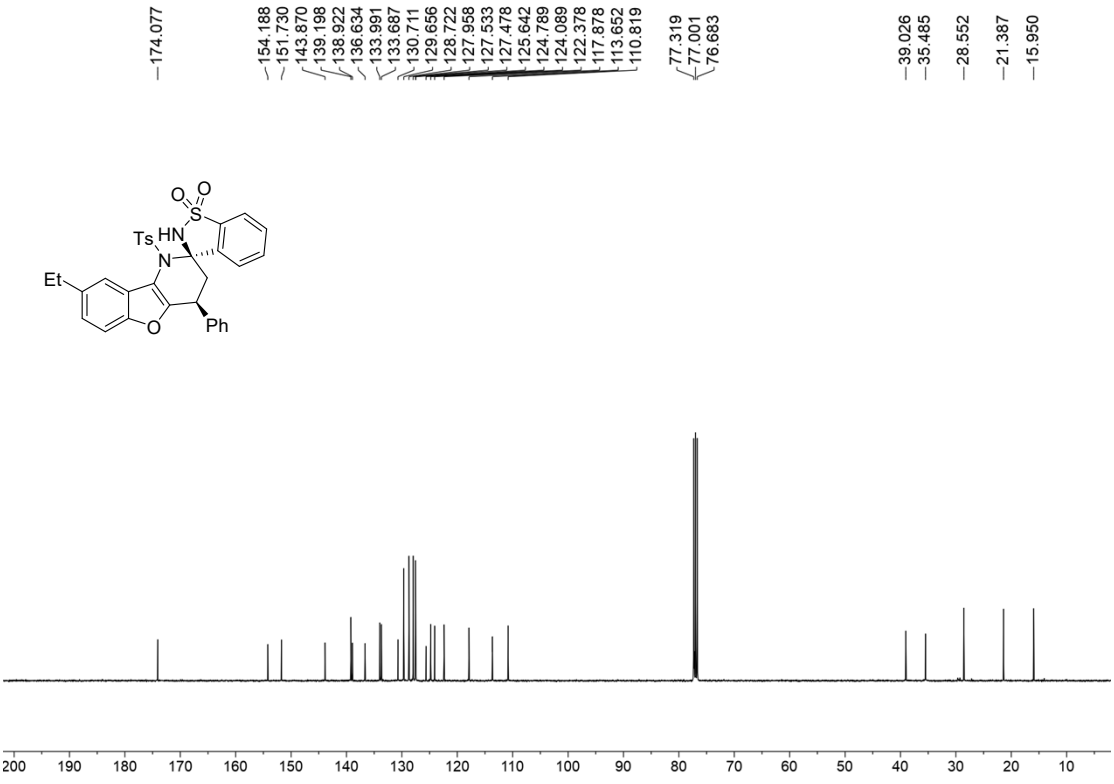


	RetTime [min]	Area [mAU*s]	Area%
1	14.949	6321740	94.54
2	17.159	365160	5.46

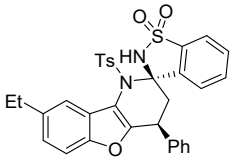
^{1}H NMR of 3ca (400 MHz, $CDCl_3$)

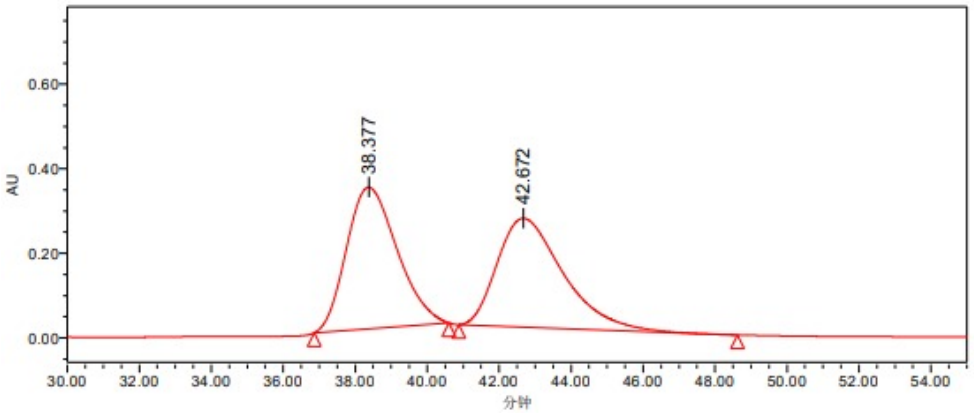


^{13}C NMR of 3ca (101 MHz, $CDCl_3$)

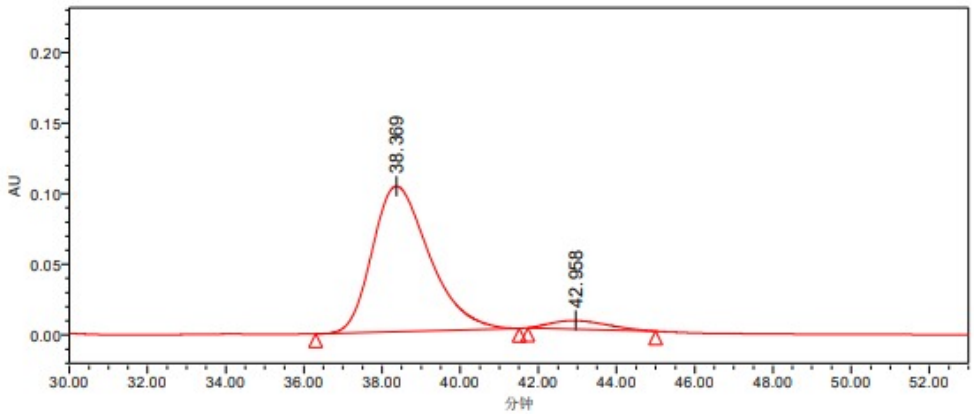


HPLC spectrum of 3ca



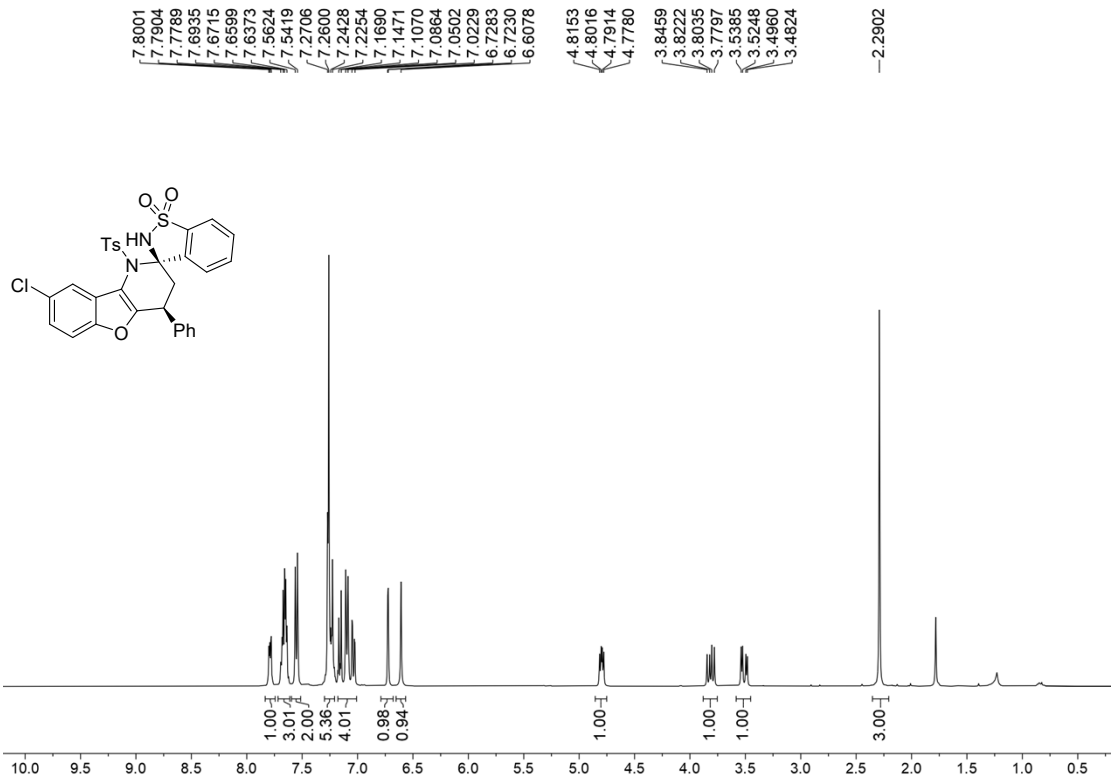


	RetTime [min]	Area [mAU*s]	Area%
1	38.377	32746231	50.00
2	42.672	32745755	50.00

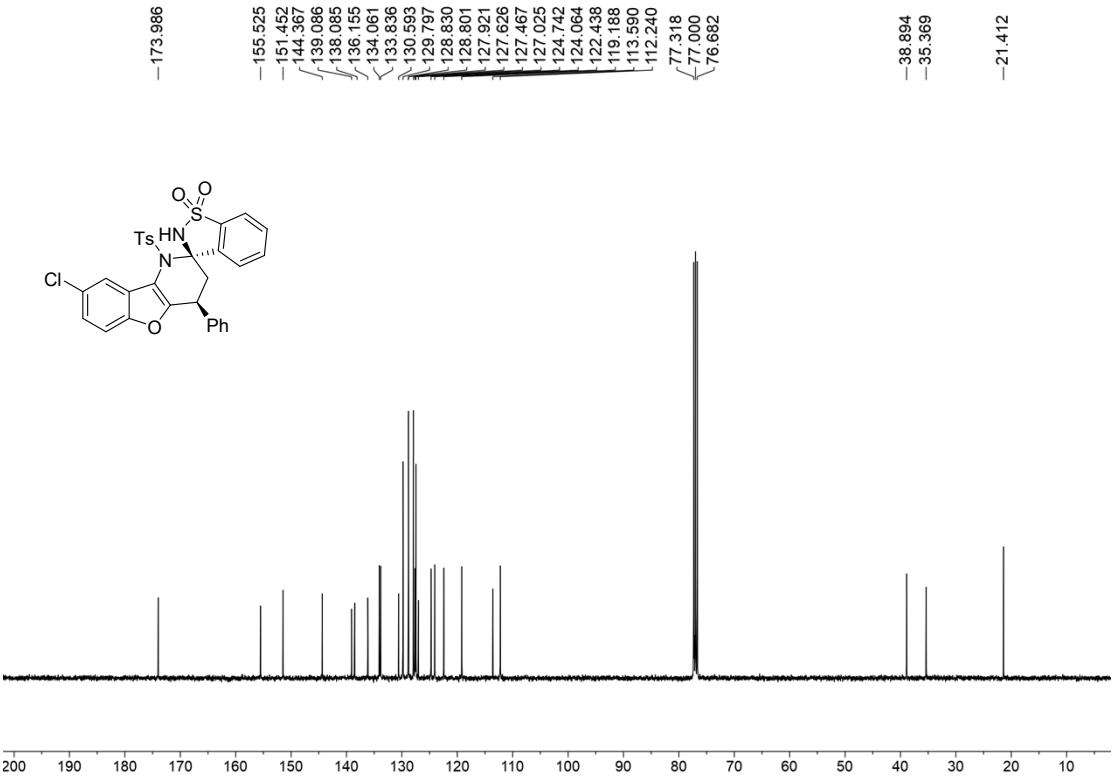


	RetTime [min]	Area [mAU*s]	Area%
1	38.369	10431940	94.51
2	42.958	605898	5.49

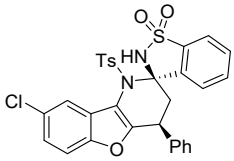
^{1}H NMR of 3da (400 MHz, $CDCl_3$)

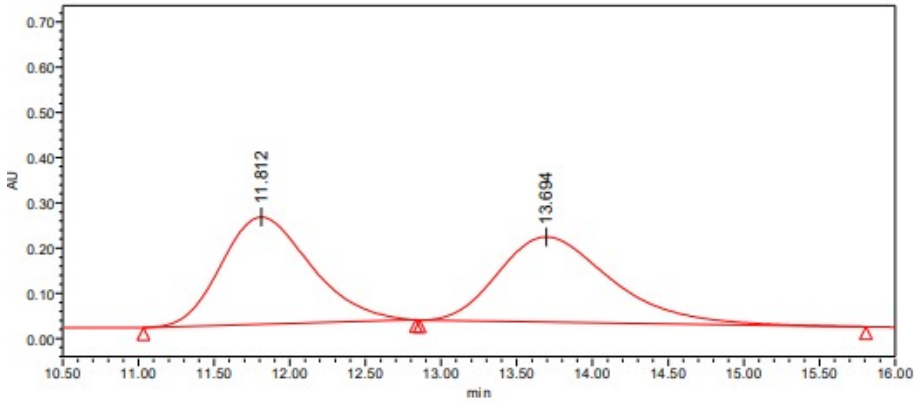


^{13}C NMR of 3da (101 MHz, $CDCl_3$)

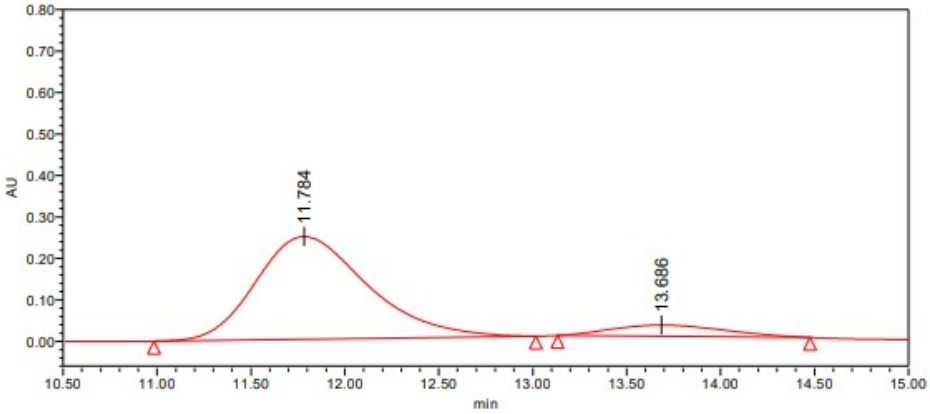


HPLC spectrum of 3da



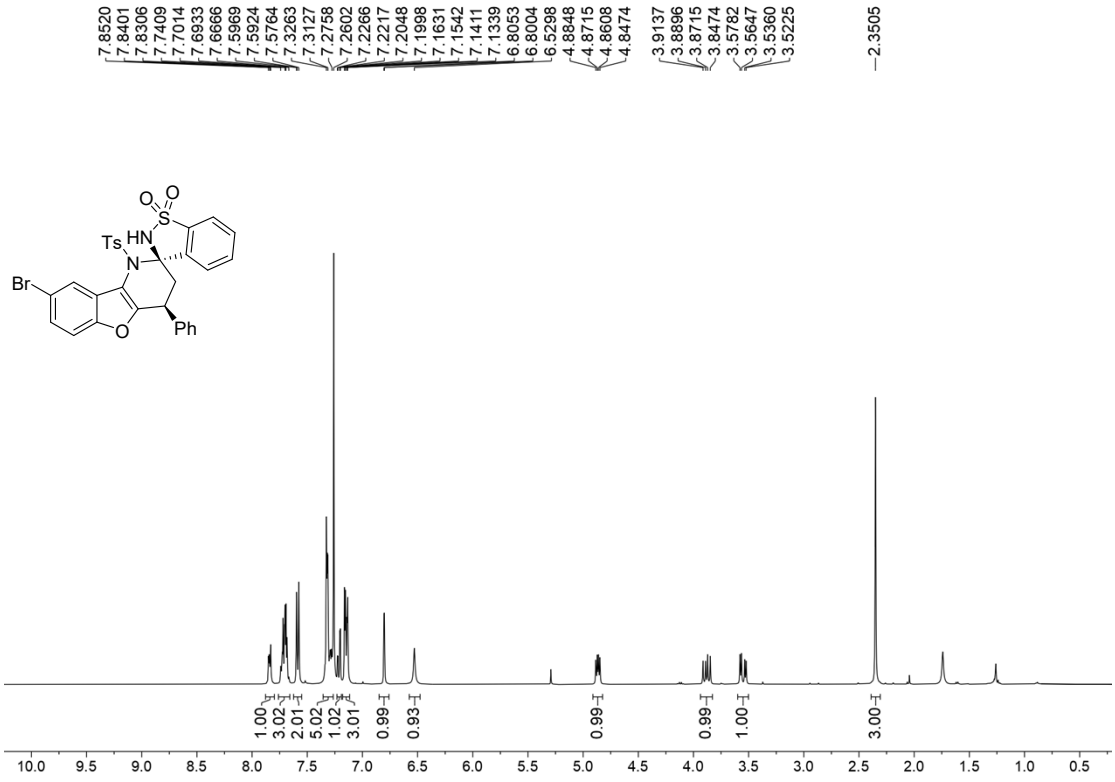


	RetTime [min]	Area [mAU*s]	Area%
1	11.812	9756410	50.07
2	13.694	9730850	49.93

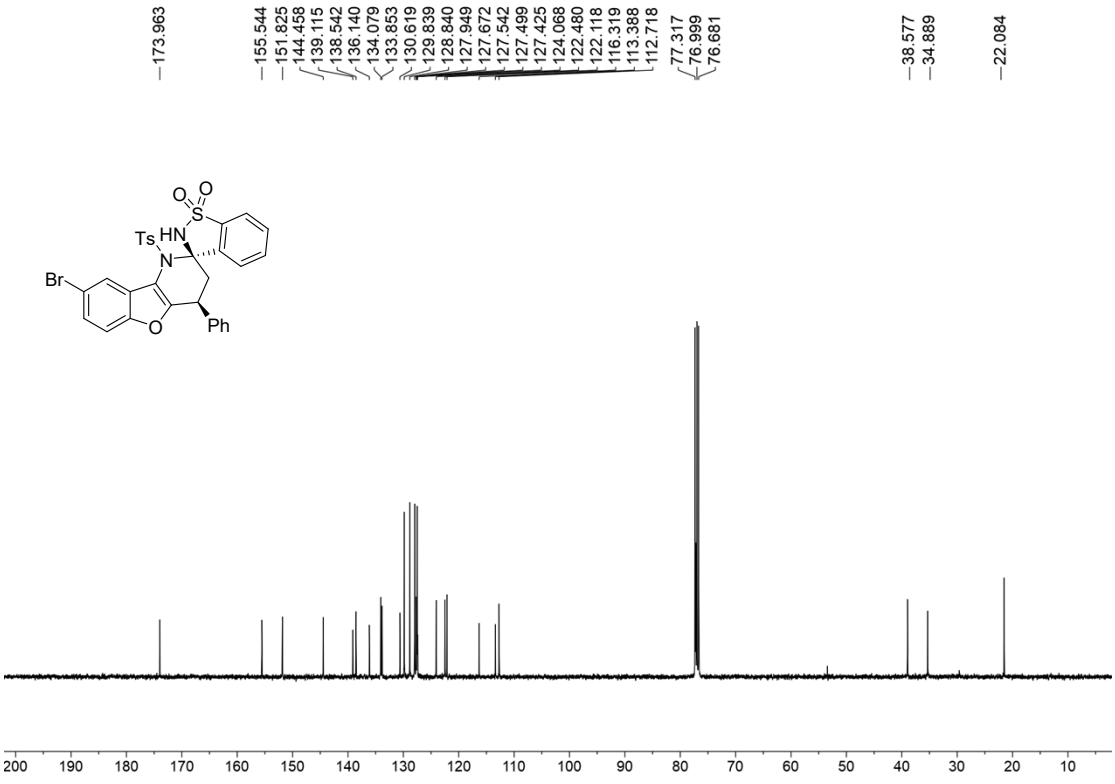


	RetTime [min]	Area [mAU*s]	Area%
1	11.784	10224565	90.06
2	13.686	1128542	9.94

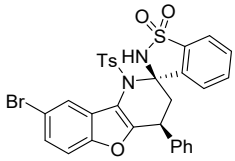
^{1}H NMR of 3ea (400 MHz, $CDCl_3$)

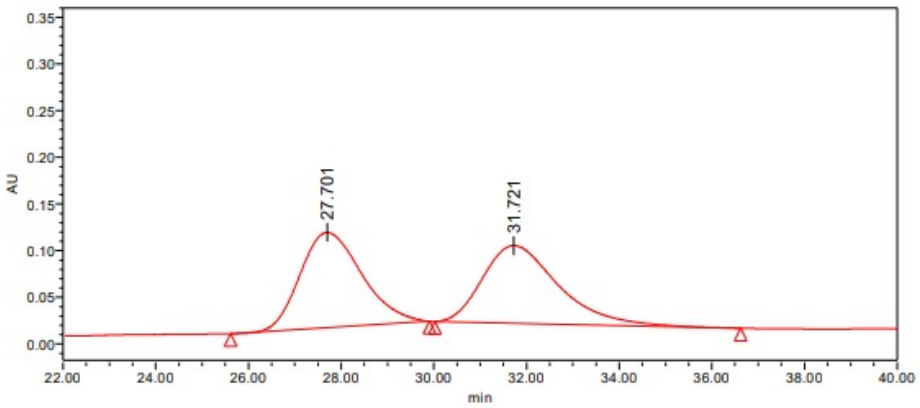


^{13}C NMR of 3ea (101 MHz, $CDCl_3$)

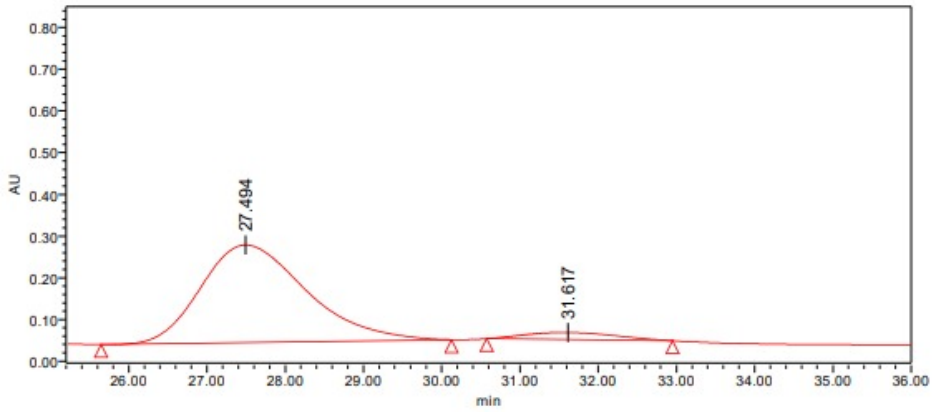


HPLC spectrum of 3ea



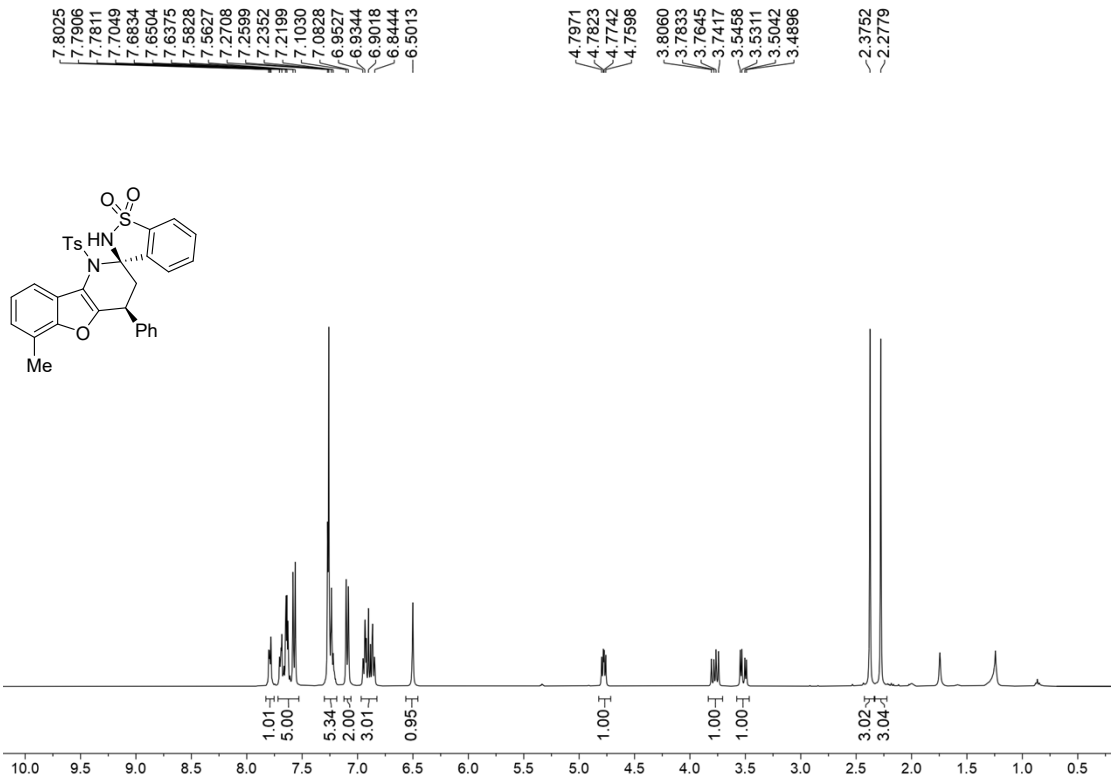


	RetTime [min]	Area [mAU*s]	Area%
1	27.701	9447485	50.00
2	31.721	9445684	50.00

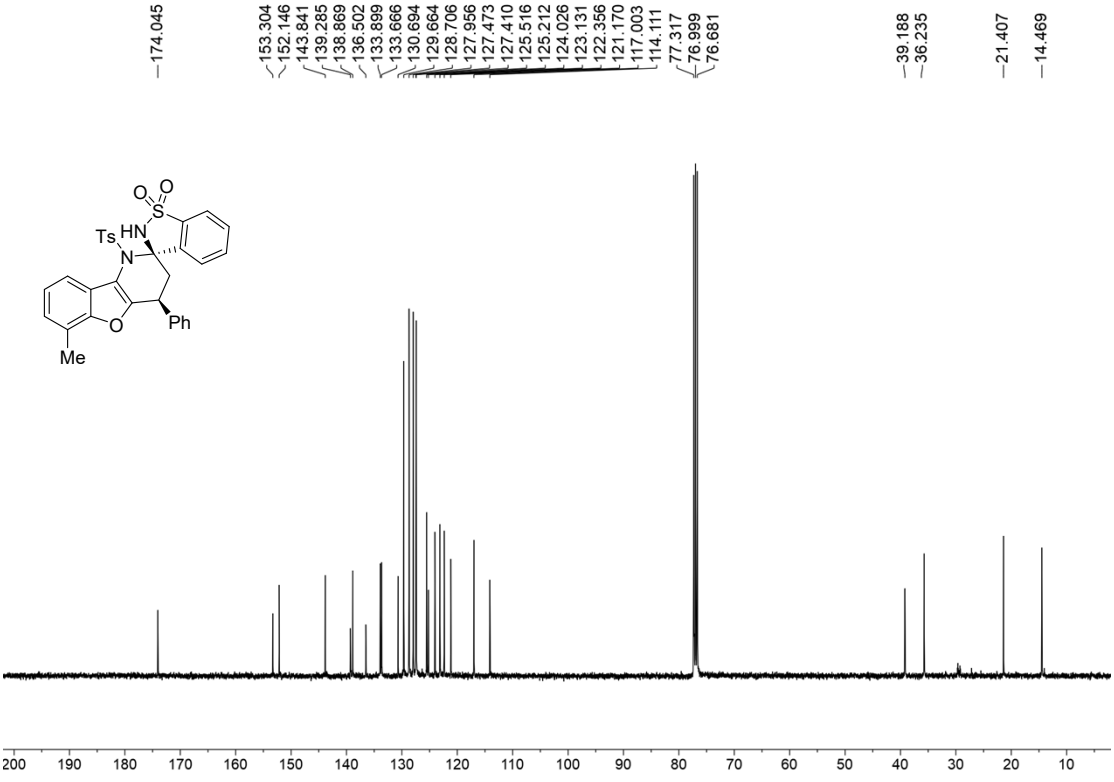


	RetTime [min]	Area [mAU*s]	Area%
1	27.494	21894994	94.03
2	31.617	1389899	5.97

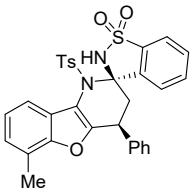
^{1}H NMR of 3fa (400 MHz, $CDCl_3$)

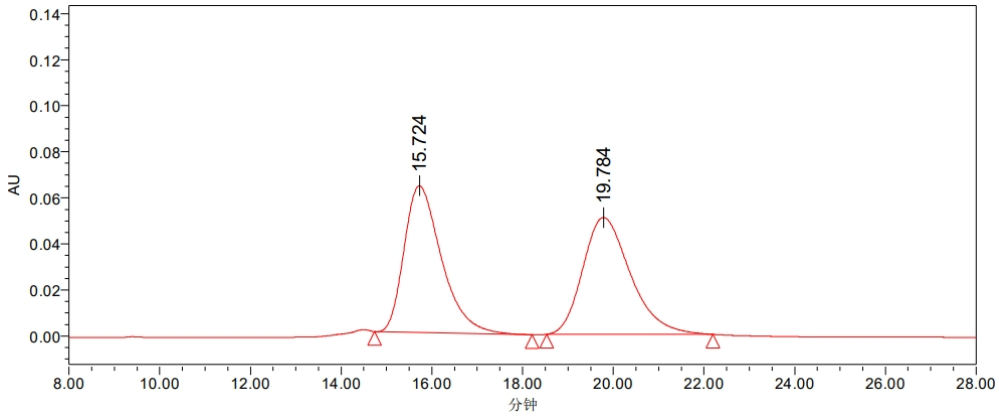


^{13}C NMR of 3fa (101 MHz, $CDCl_3$)

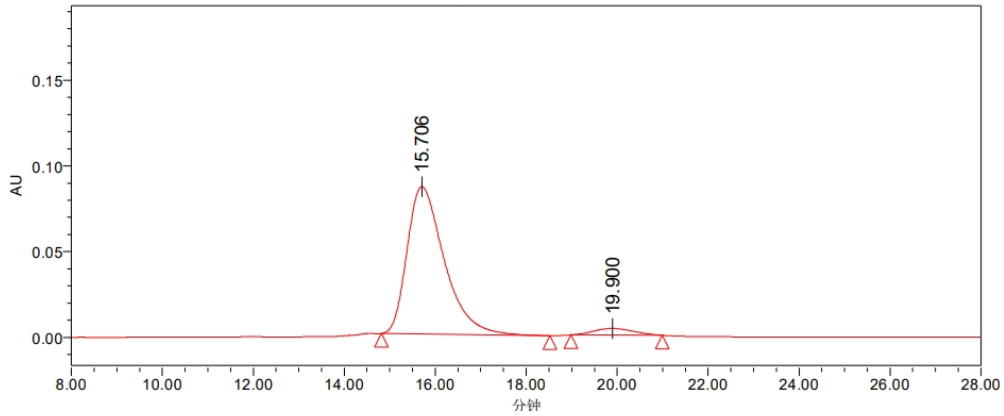


HPLC spectrum of 3fa



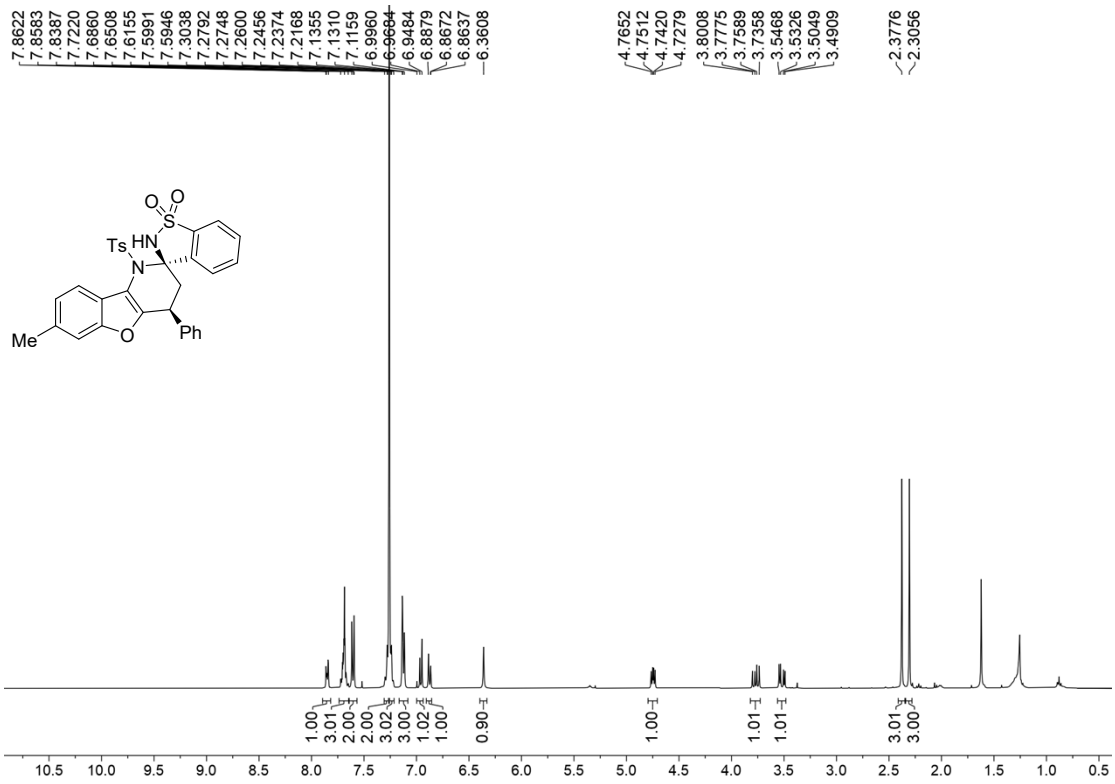


	RetTime [min]	Area [mAU*s]	Area%
1	15.724	3660516	49.68
2	19.784	3708146	50.32

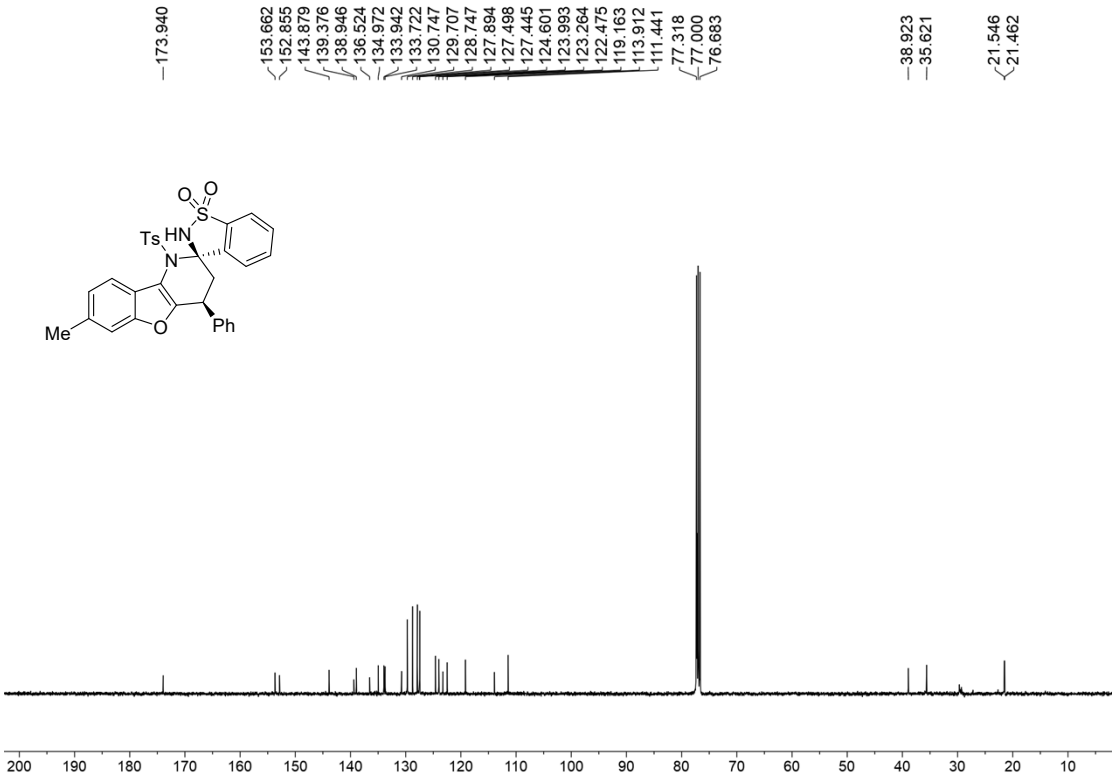


	RetTime [min]	Area [mAU*s]	Area%
1	15.706	4897855	95.44
2	19.900	233901	4.56

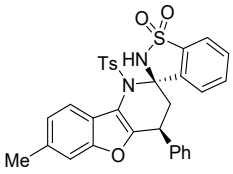
^{1}H NMR of 3ga (400 MHz, $CDCl_3$)

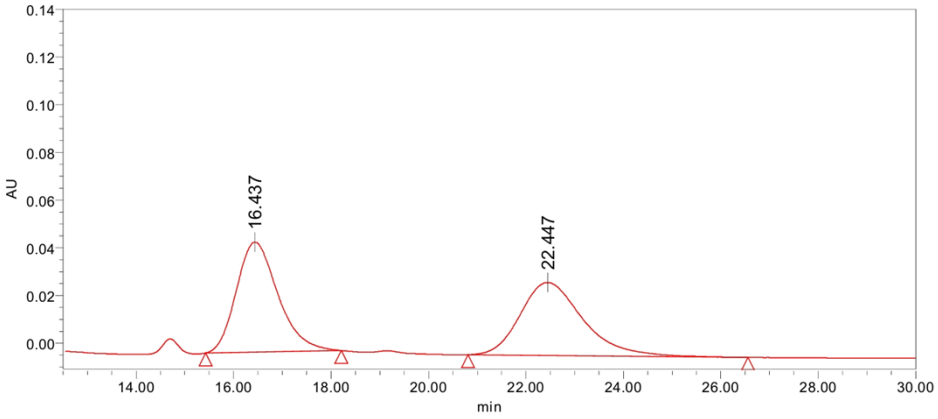


^{13}C NMR of 3ga (101 MHz, $CDCl_3$)

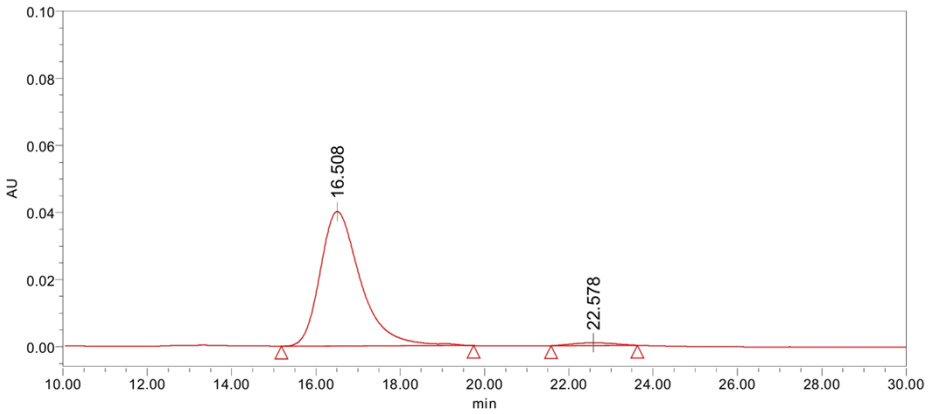


HPLC spectrum of 3ga



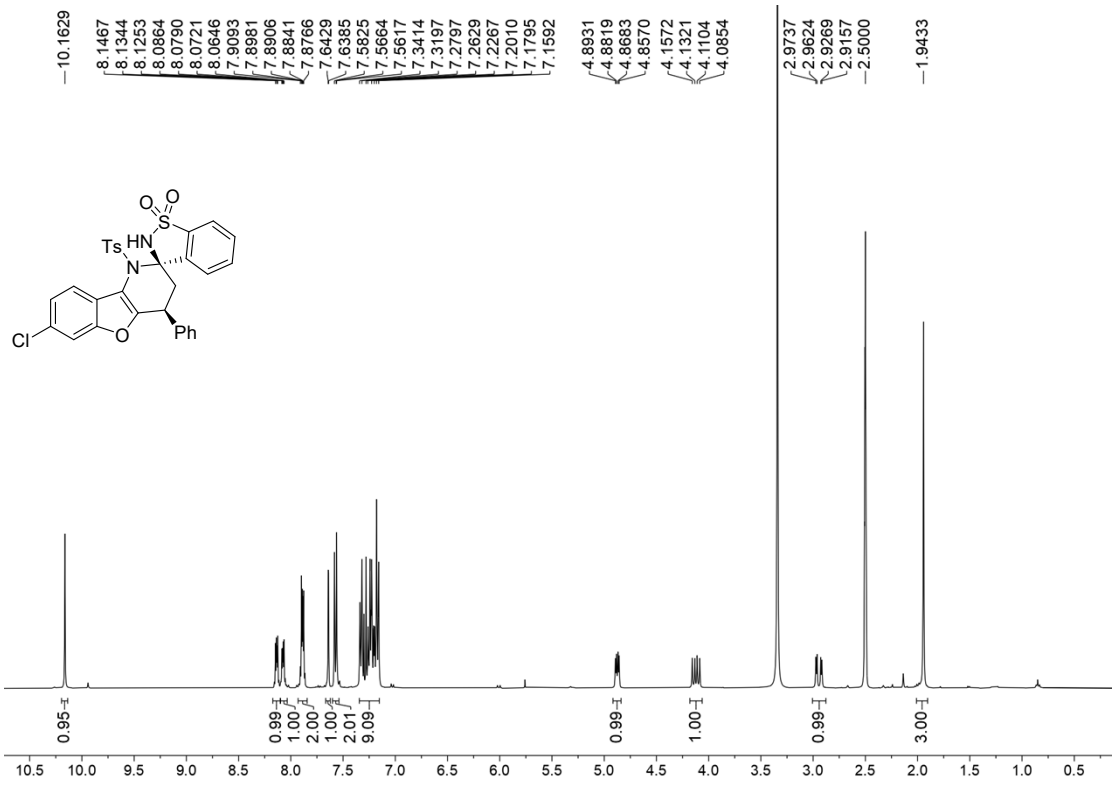


	RetTime [min]	Area [mAU*s]	Area%
1	16.437	2740867	50.00
2	22.447	2740983	50.00

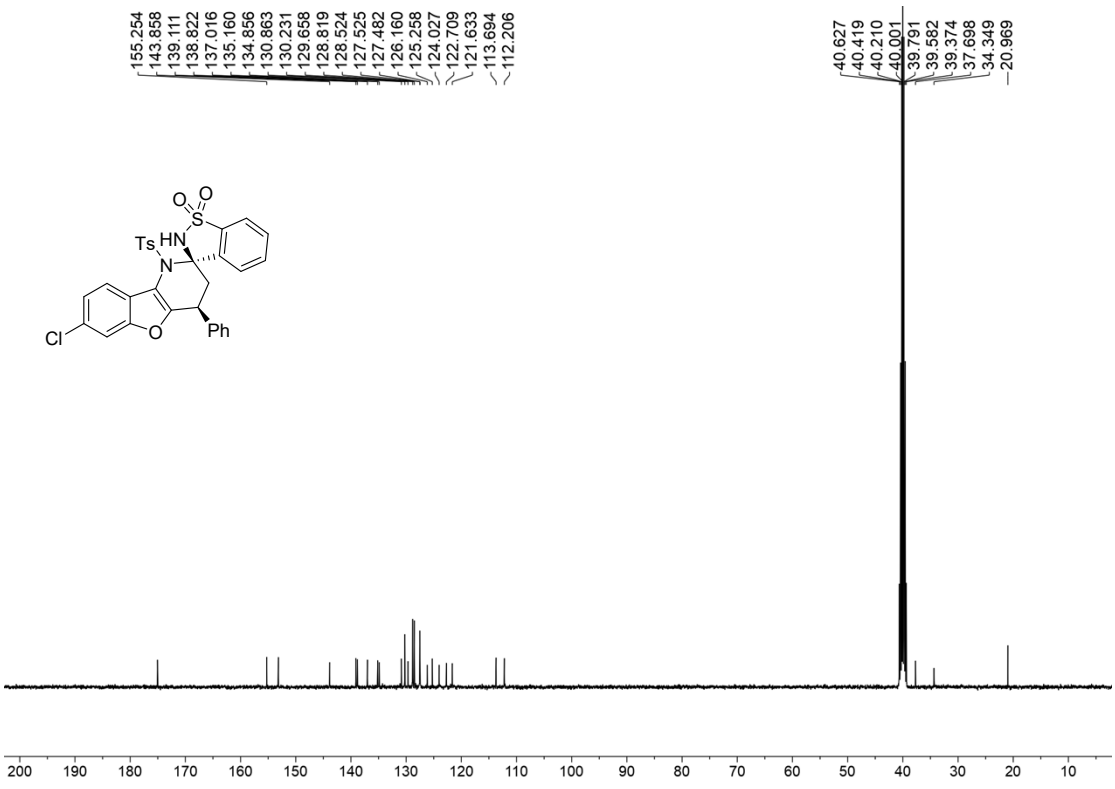


	RetTime [min]	Area [mAU*s]	Area%
1	16.508	2666047	98.01
2	22.578	54075	1.99

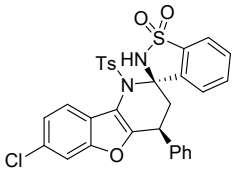
^{1}H NMR of 3ha (400 MHz, DMSO-d_6)

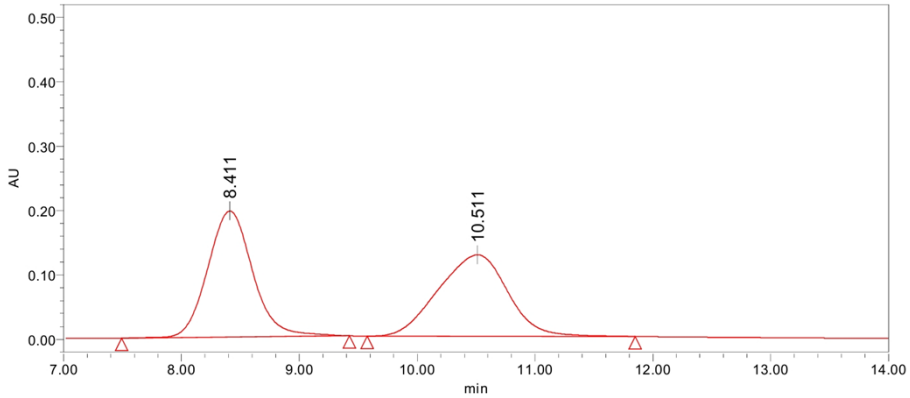


^{13}C NMR of 3ha (101 MHz, DMSO-d_6)

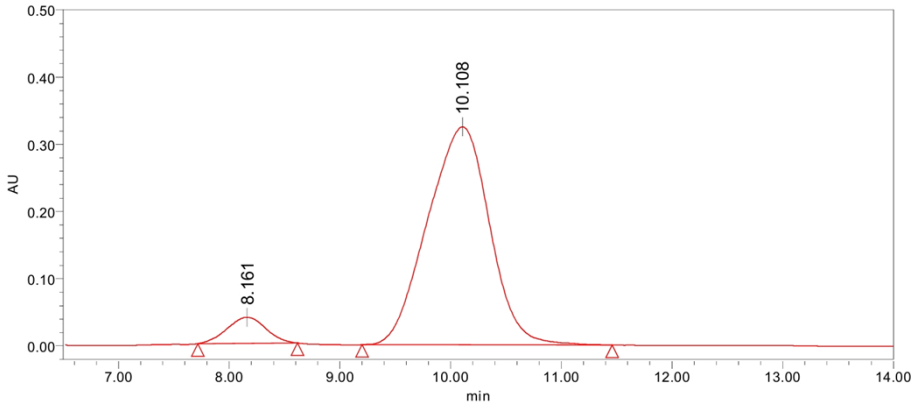


HPLC spectrum of 3ha



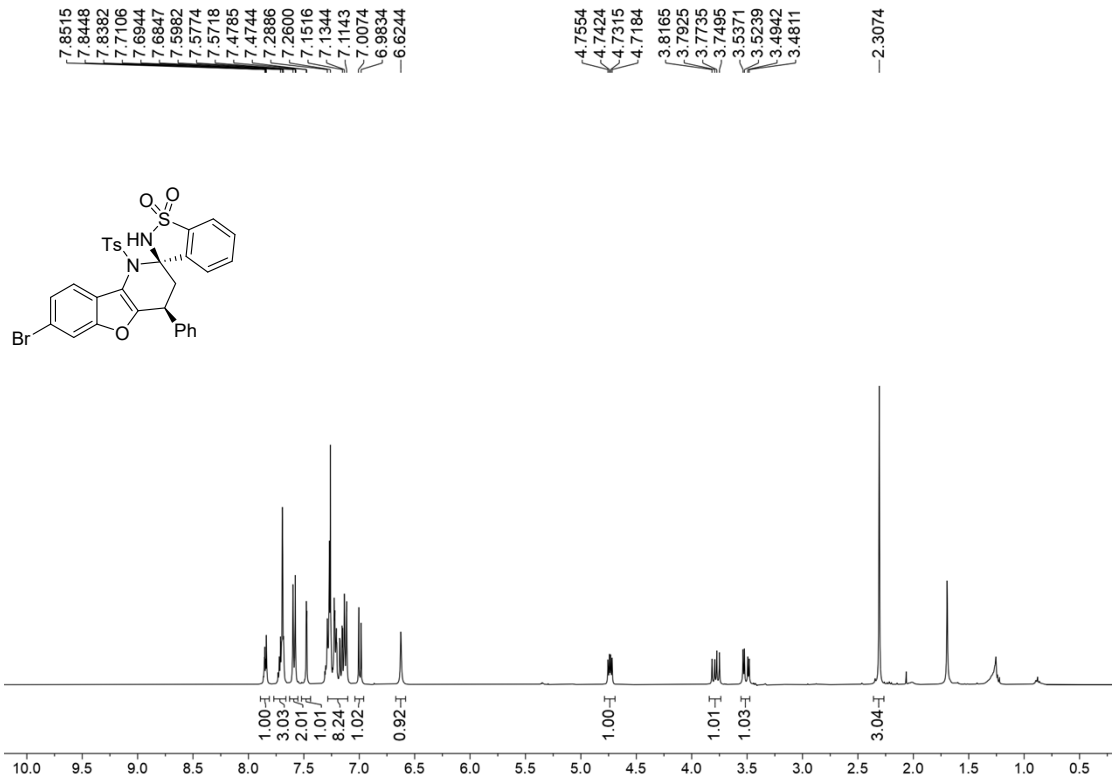


	RetTime [min]	Area [mAU*s]	Area%
1	8.411	5192632	50.03
2	10.511	5177458	49.97

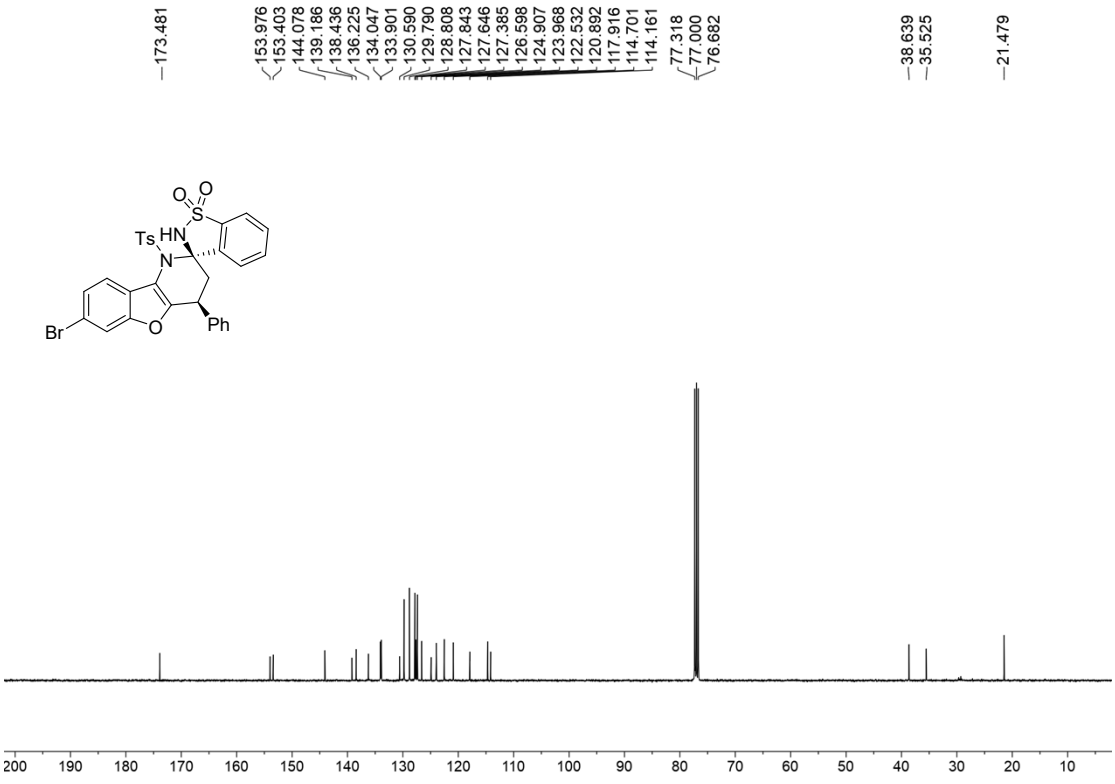


	RetTime [min]	Area [mAU*s]	Area%
1	8.161	942363	6.93
2	10.108	12648251	93.07

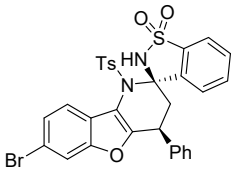
^{1}H NMR of 3ia (400 MHz, $CDCl_3$)

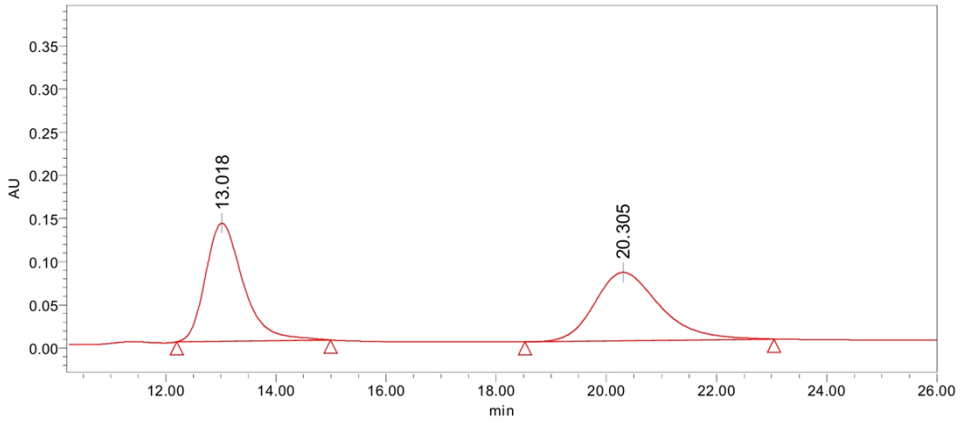


^{13}C NMR of 3ia (101 MHz, $CDCl_3$)

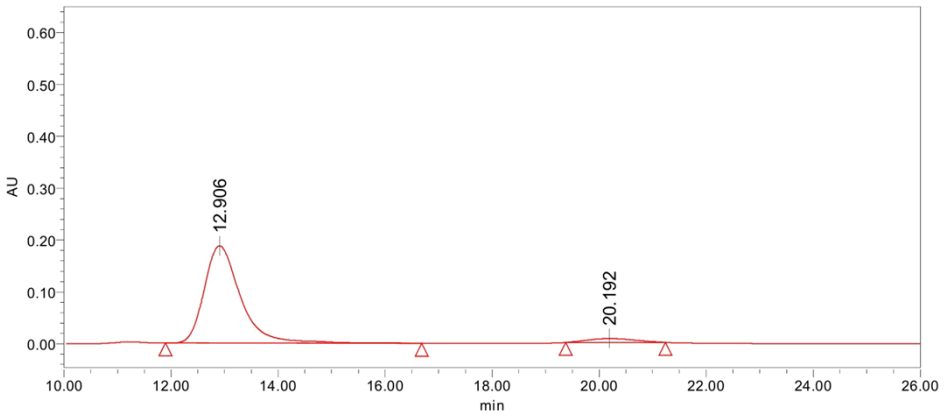


HPLC spectrum of 3ia



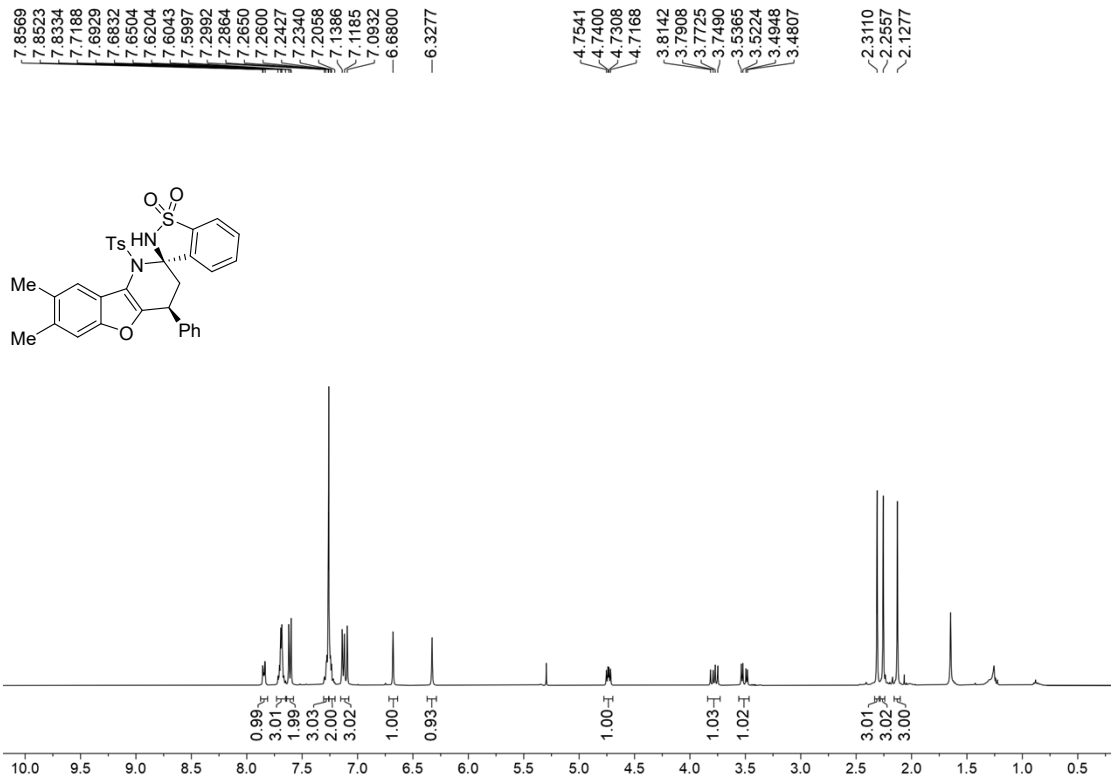


	RetTime [min]	Area [mAU*s]	Area%
1	13.018	6491162	50.00
2	20.305	6491591	50.00

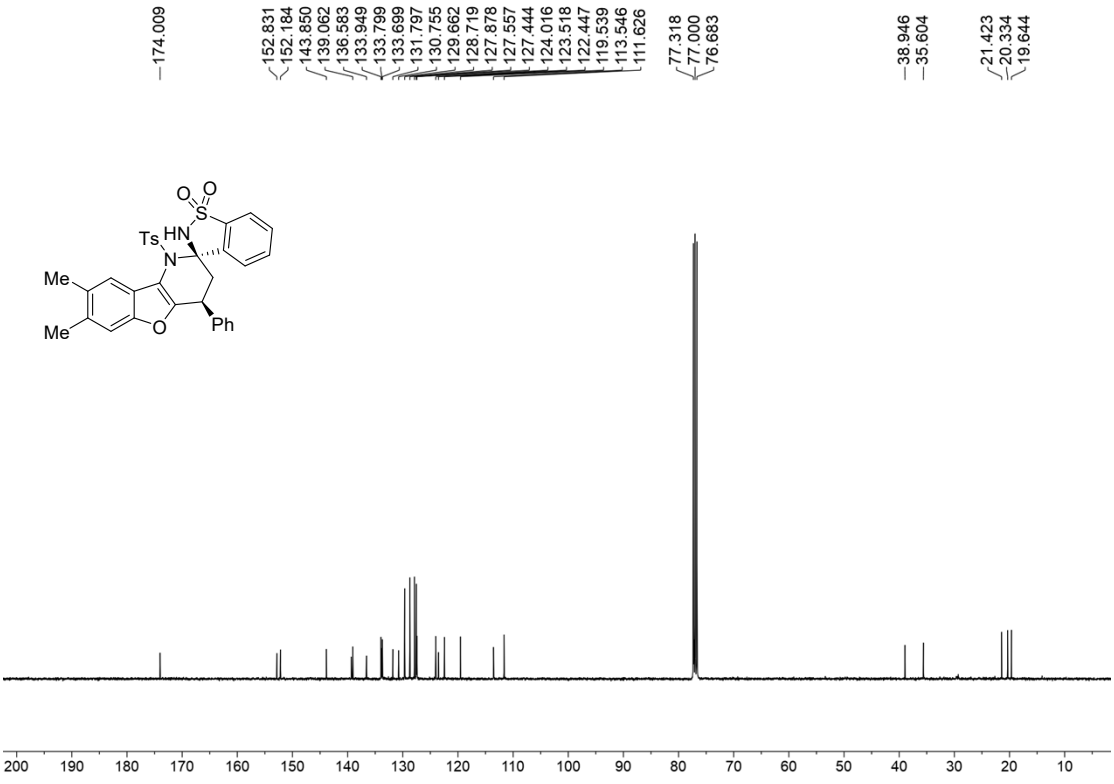


	RetTime [min]	Area [mAU*s]	Area%
1	12.906	8863823	95.08
2	20.192	458316	4.92

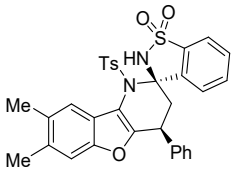
^{1}H NMR of 3ja (400 MHz, $CDCl_3$)

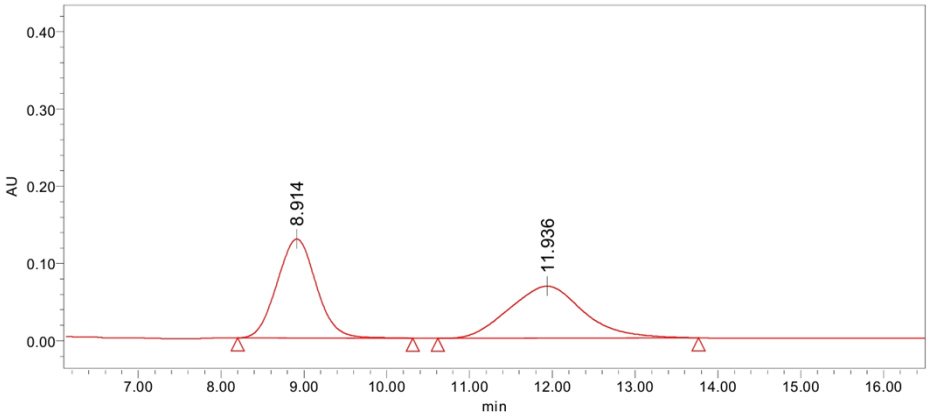


^{13}C NMR of 3ja (101 MHz, $CDCl_3$)

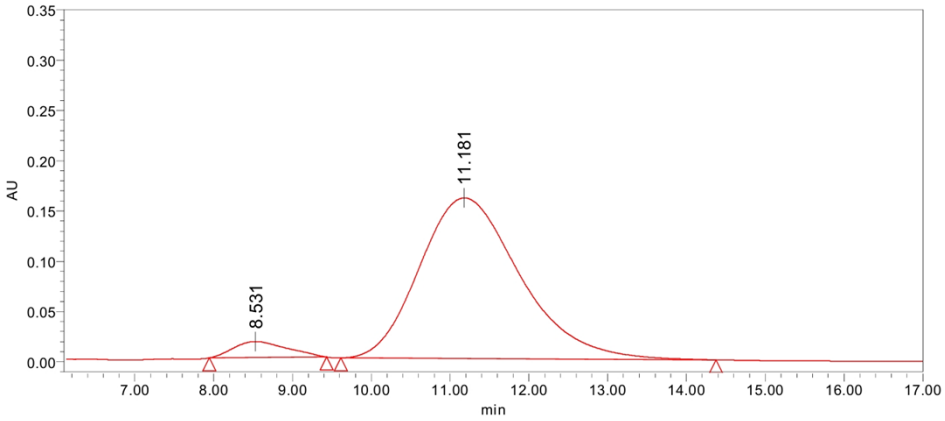


HPLC spectrum of 3ja



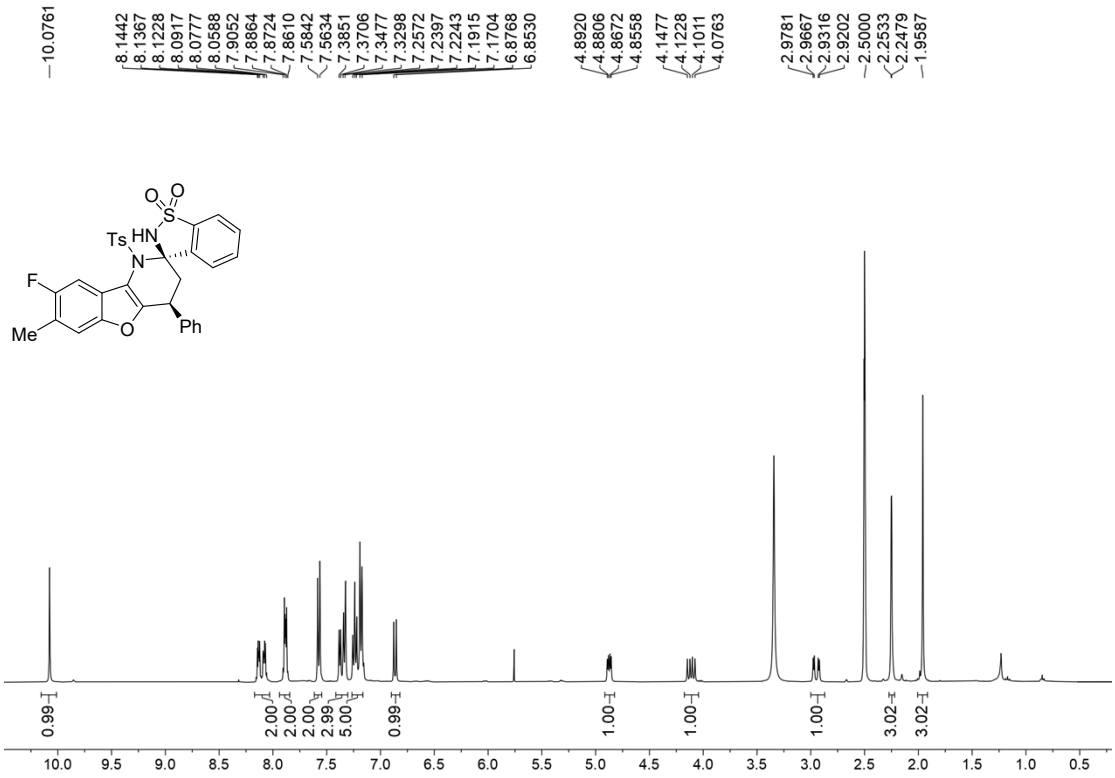


	RetTime [min]	Area [mAU*s]	Area%
1	8.914	4210849	50.00
2	11.936	4211346	50.00

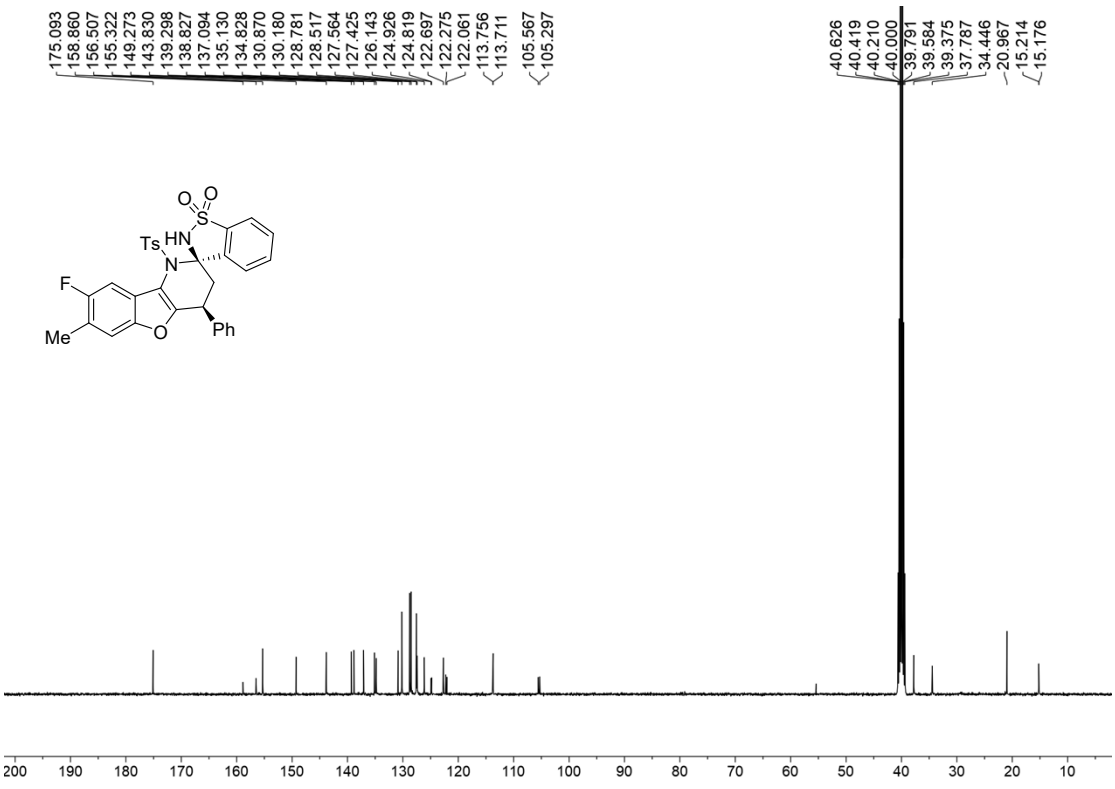


	RetTime [min]	Area [mAU*s]	Area%
1	8.531	751615	5.04
2	11.181	14162366	94.96

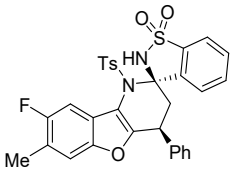
^{1}H NMR of 3ka (400 MHz, DMSO-d_6)

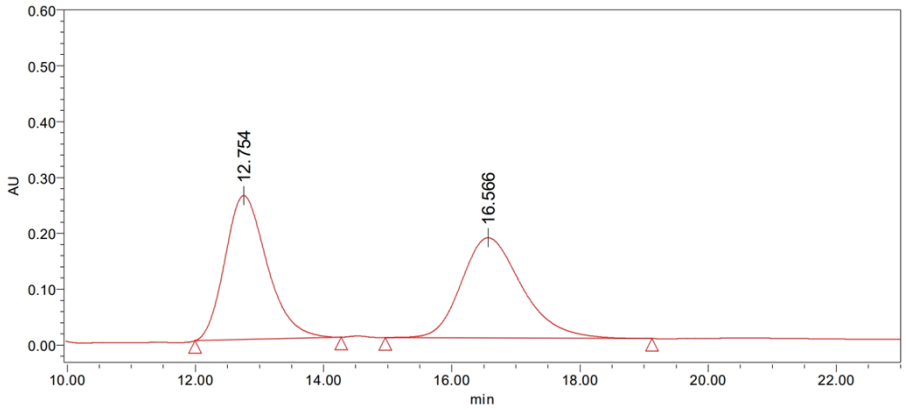


^{13}C NMR of 3ka (101 MHz, DMSO-d_6)

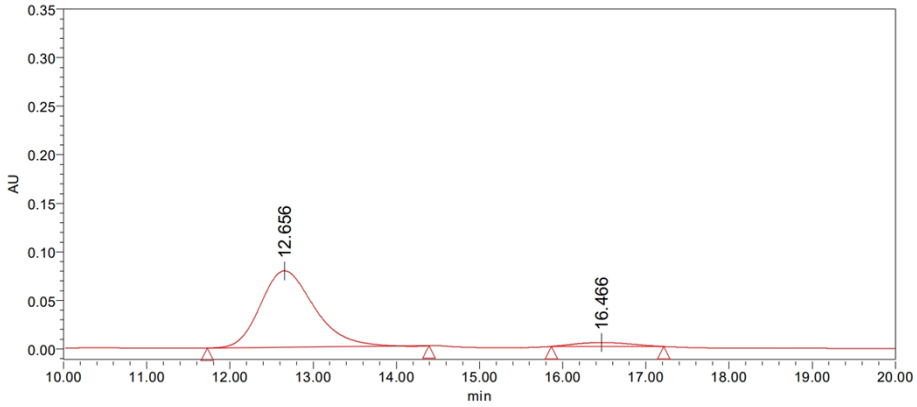


HPLC spectrum of 3ka



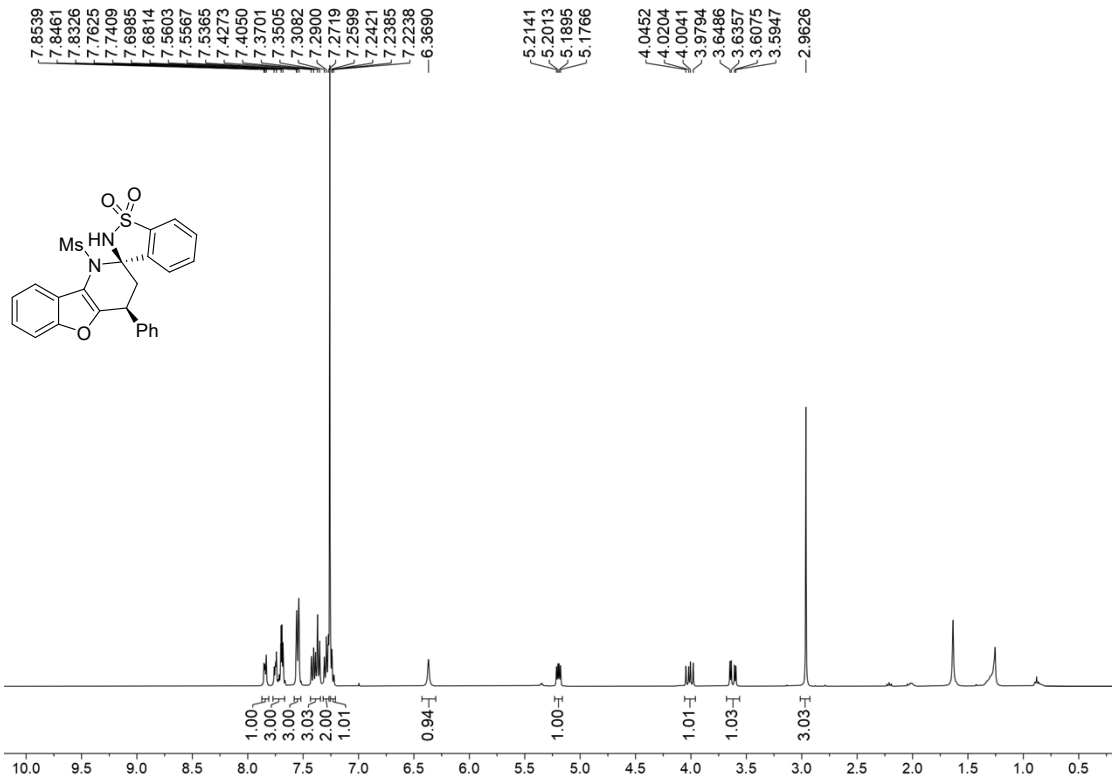


	RetTime [min]	Area [mAU*s]	Area%
1	12.754	11771309	50.00
2	16.566	11772357	50.00

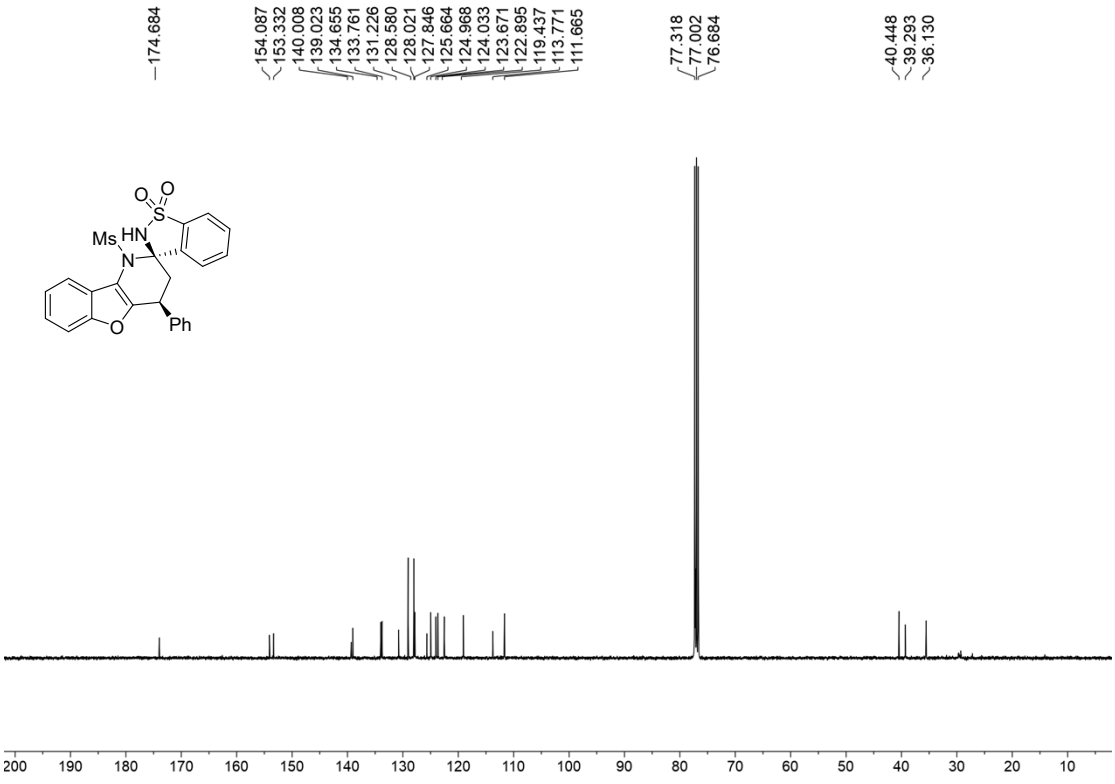


	RetTime [min]	Area [mAU*s]	Area%
1	12.656	3541998	94.92
2	16.466	189736	5.08

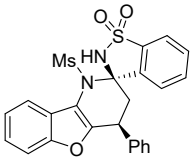
^{1}H NMR of 3la (400 MHz, $CDCl_3$)

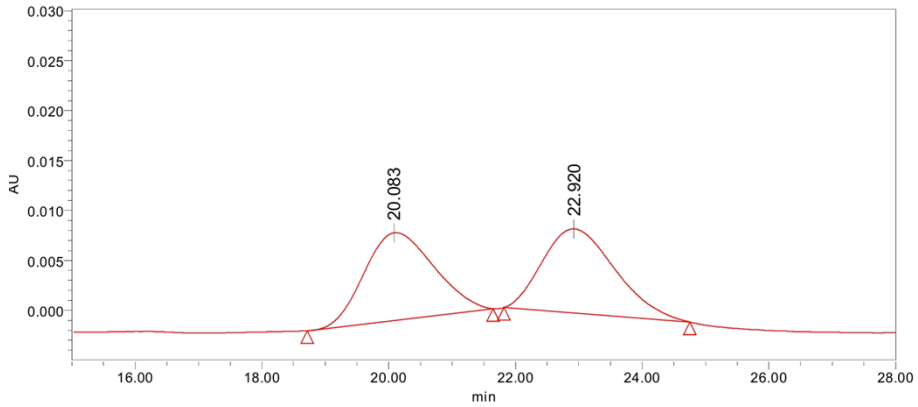


^{13}C NMR of 3la (101 MHz, $CDCl_3$)

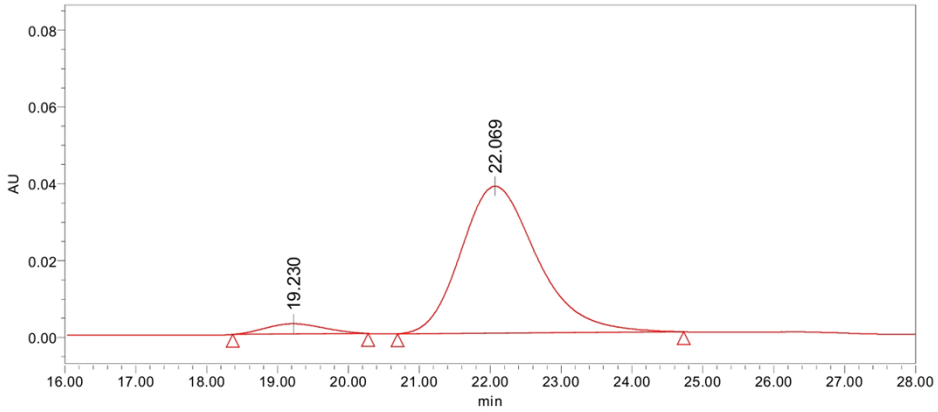


HPLC spectrum of 3la



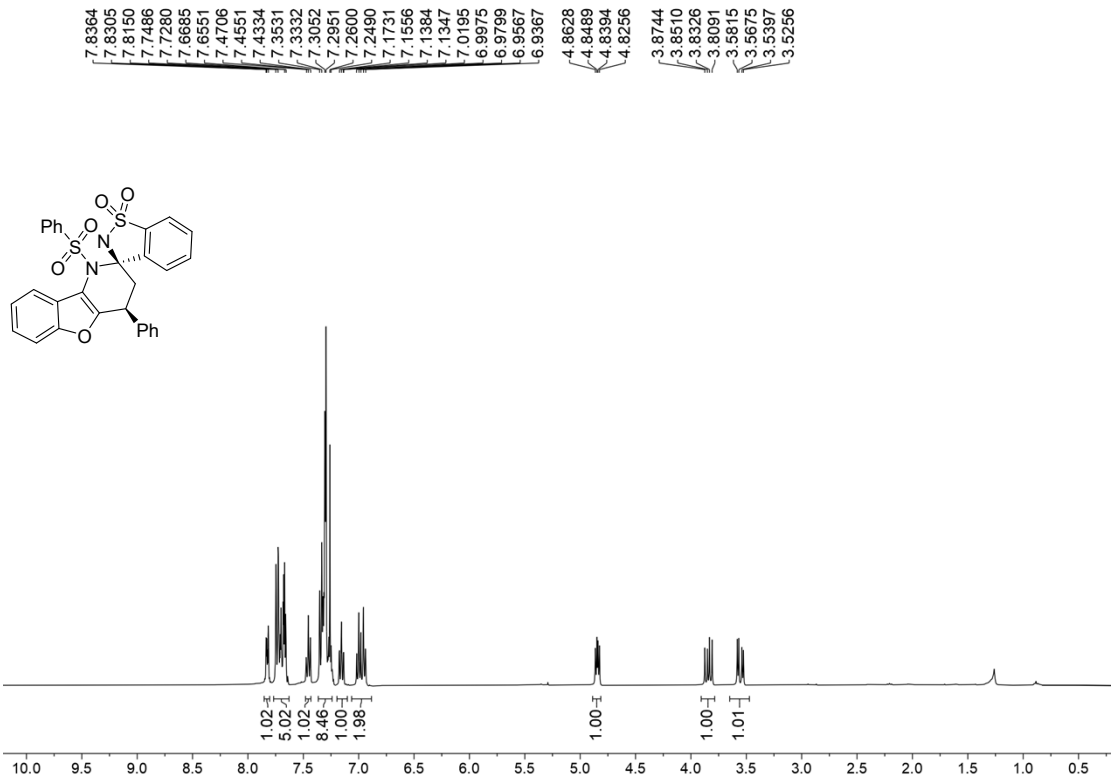


	RetTime [min]	Area [mAU*s]	Area%
1	20.083	669624	49.90
2	22.920	672414	50.10

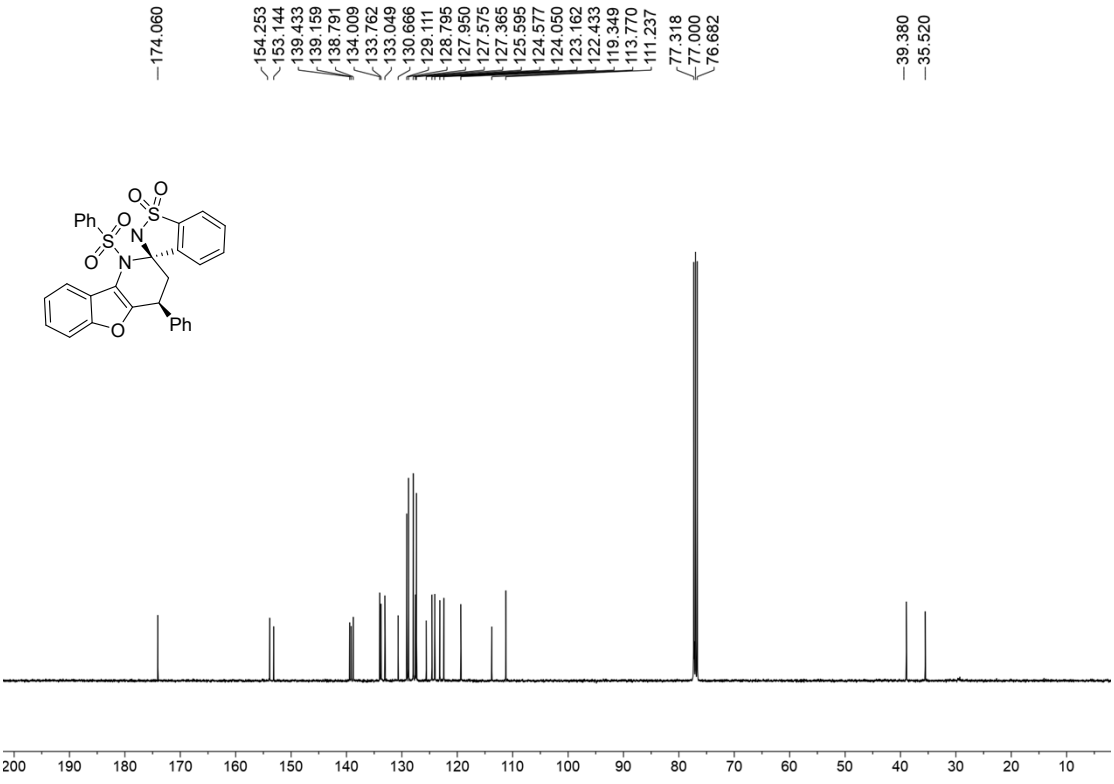


	RetTime [min]	Area [mAU*s]	Area%
1	19.230	153318	5.09
2	22.069	2855945	94.91

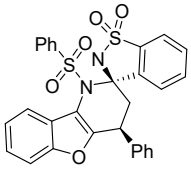
^{1}H NMR of 3ma (400 MHz, $CDCl_3$)

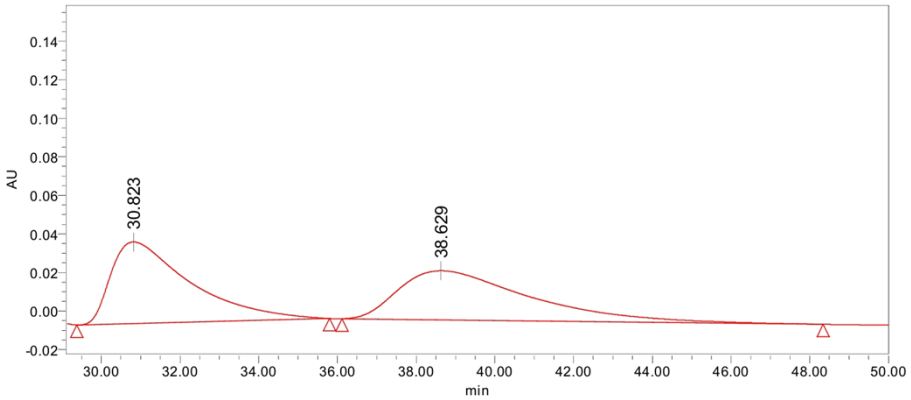


^{13}C NMR of 3ma (101 MHz, $CDCl_3$)

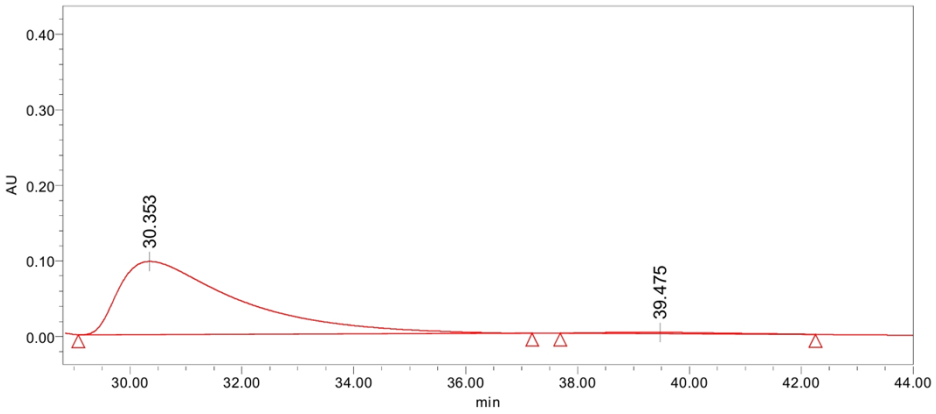


HPLC spectrum of 3ma



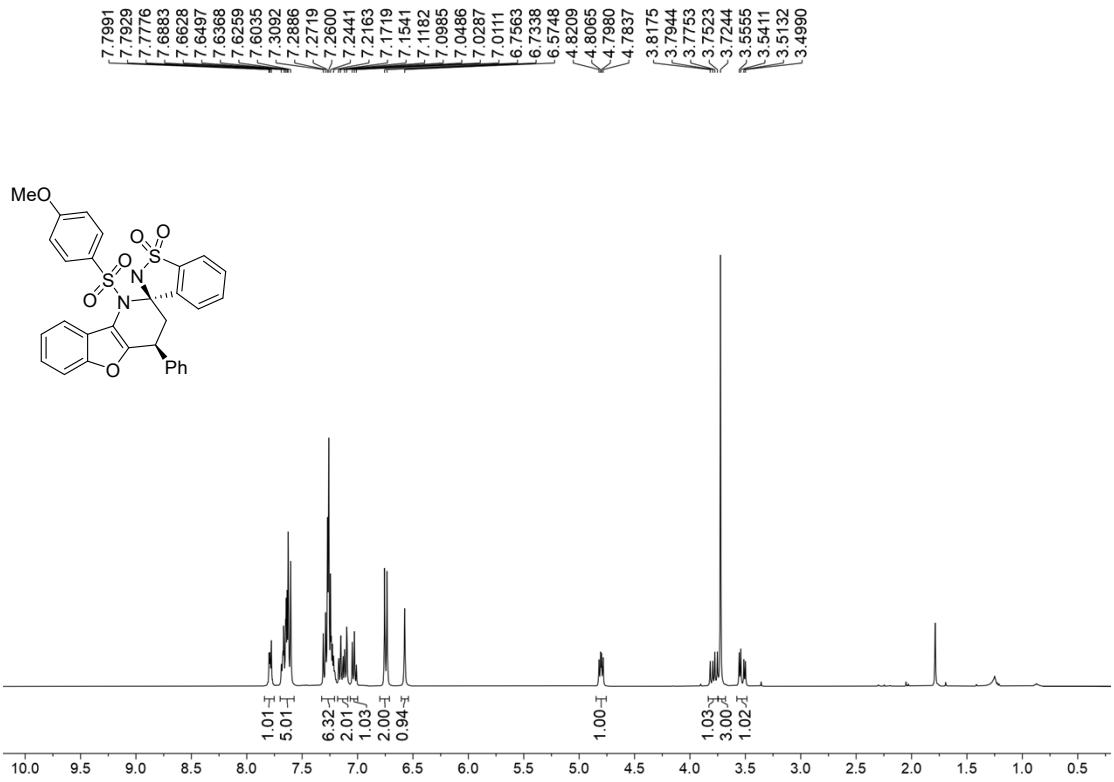


	RetTime [min]	Area [mAU*s]	Area%
1	30.823	5912780	50.08
2	38.629	5894327	49.92

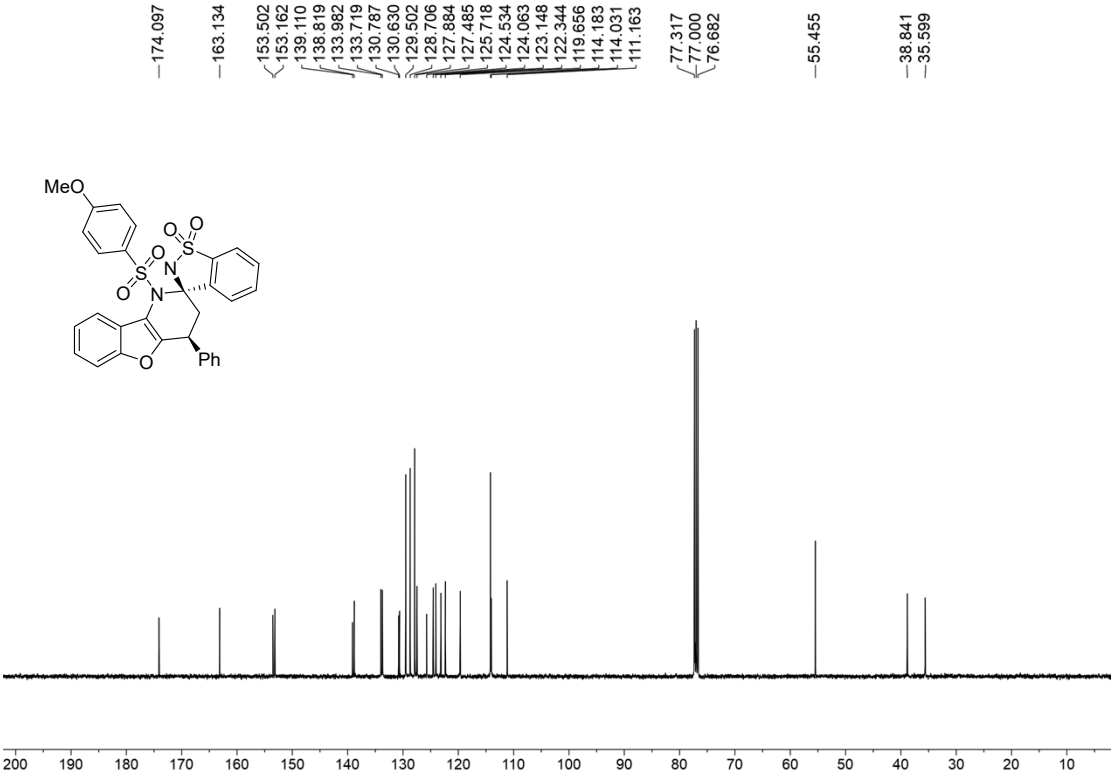


	RetTime [min]	Area [mAU*s]	Area%
1	30.353	14299382	98.22
2	39.475	259152	1.78

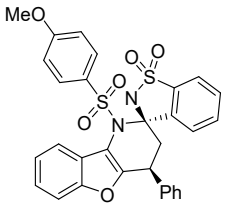
^{1}H NMR of 3na (400 MHz, $CDCl_3$)

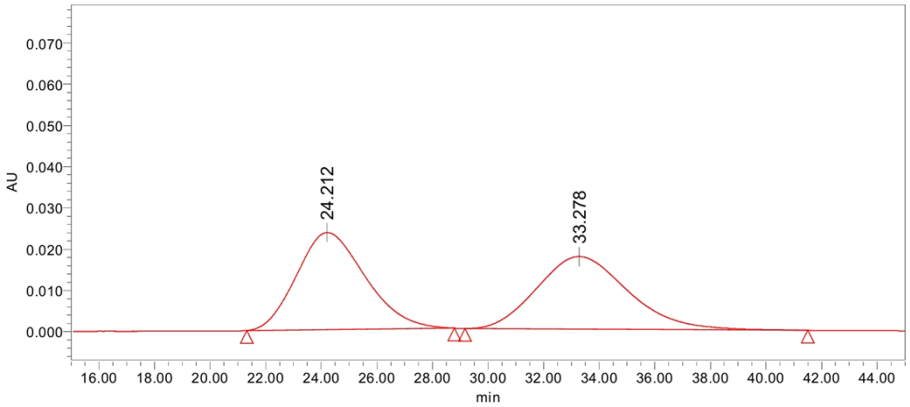


^{13}C NMR of 3na (101 MHz, $CDCl_3$)

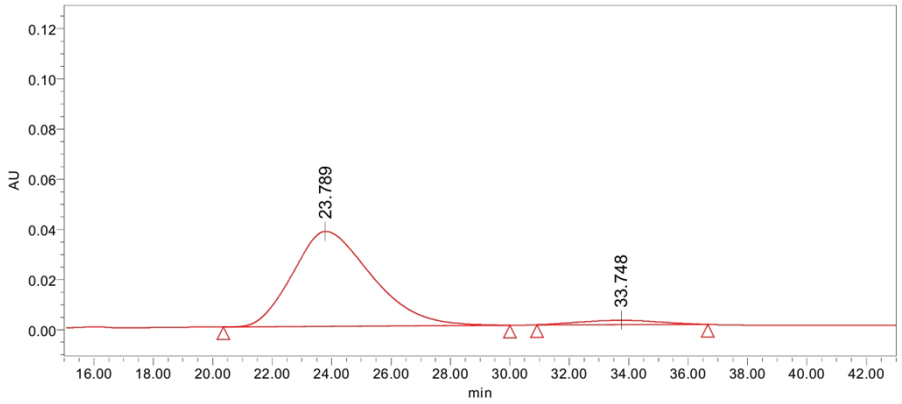


HPLC spectrum of 3na



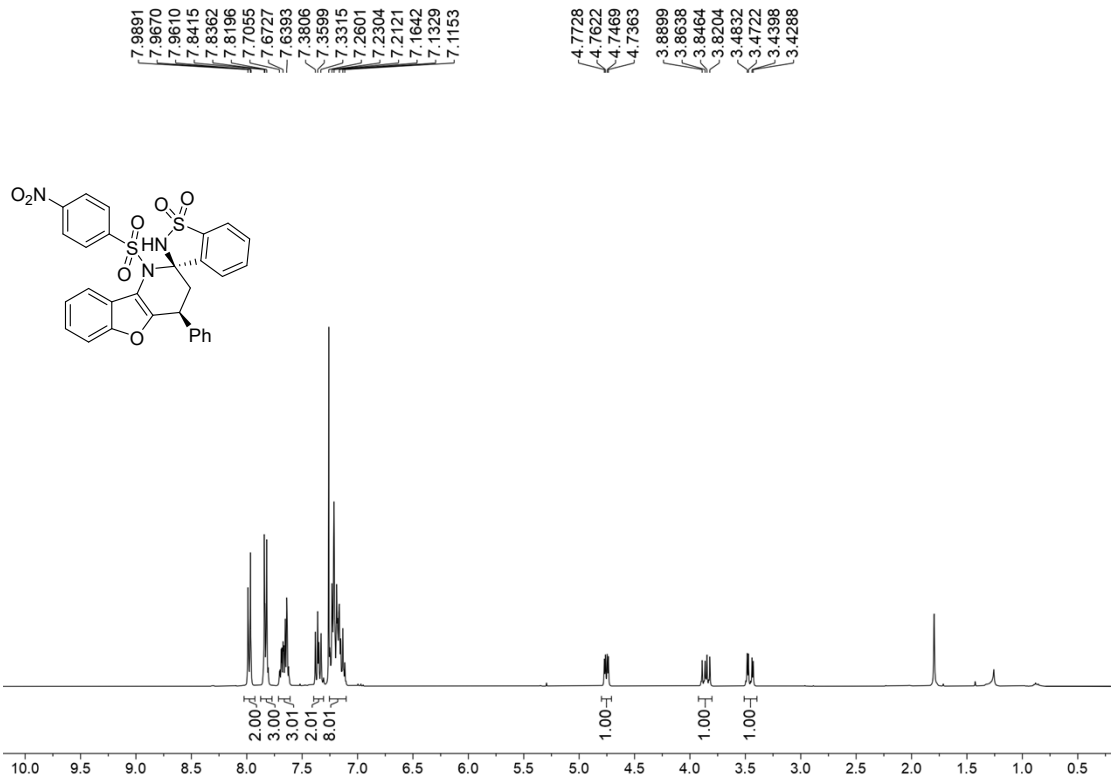


	RetTime [min]	Area [mAU*s]	Area%
1	24.212	4044141	50.23
2	33.278	4006931	49.77

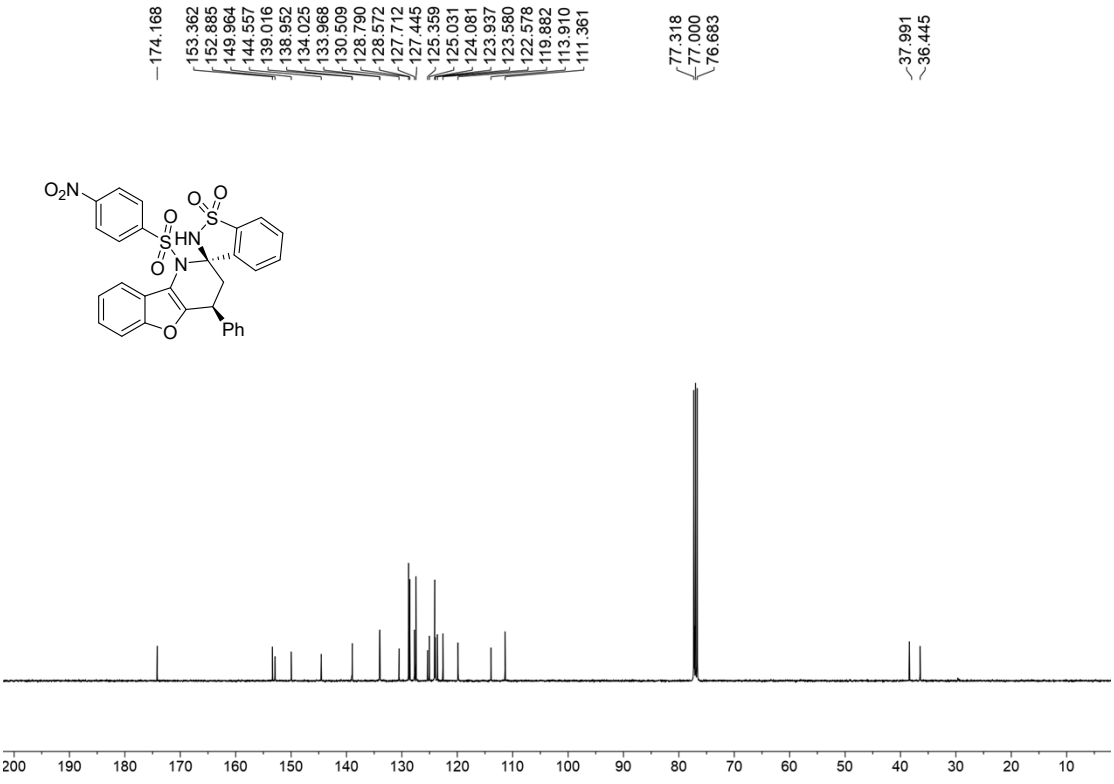


	RetTime [min]	Area [mAU*s]	Area%
1	23.789	6977916	95.57
2	33.748	323283	4.43

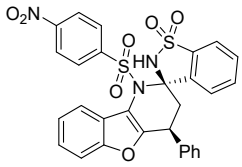
^{1}H NMR of 3oa (400 MHz, $CDCl_3$)

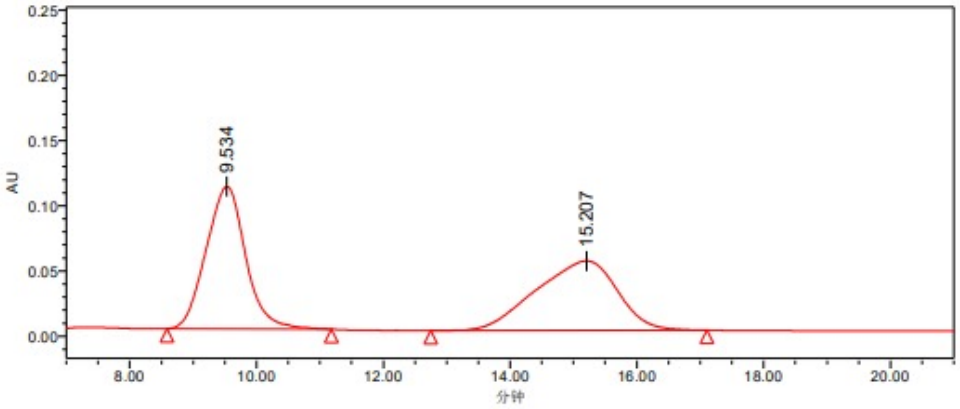


^{13}C NMR of 3oa (101 MHz, $CDCl_3$)

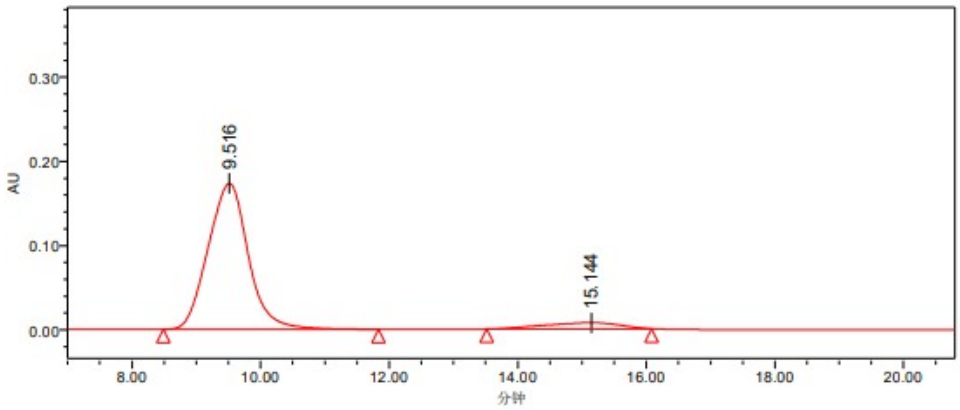


HPLC spectrum of 3oa





	RetTime [min]	Area [mAU*s]	Area%
1	9.534	4738084	50.00
2	15.207	4738892	50.00



	RetTime [min]	Area [mAU*s]	Area%
1	9.516	7529901	92.65
2	15.144	597160	7.35