Supplementary Information

Enantioselective construction of trifluoromethylated quaternary stereocenters via Rh-catalyzed asymmetric dehydrated arylation of unprotected hemiaminals

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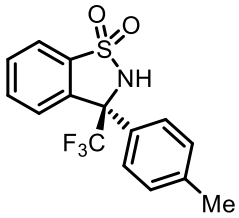
Contents

1. General information

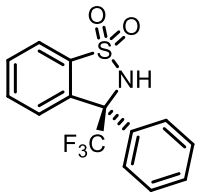
All reactions were carried out in dry solvents under argon atmosphere unless otherwise noted. All solvents were dried and distilled before use according to the standard methods. The progress of all reactions was monitored by thin layer chromatography to ensure that the reactions had reached completion. NMR spectra were recorded on Varian spectrometers (400 MHz for ^{1}H, and 125 MHz for ^{13}C, 375 MHz for ^{19}F). Chemical shifts are reported in δ (ppm) referenced to an internal $SiMe_4$ standard for ^{1}H NMR and chloroform-*d* (δ 77.36) for ^{13}C NMR. MS and HRMS were measured in EI or ESI mode, and the mass analyzer type used for HRMS was Magnetic Sector. Chiral HPLC was performed on a JASCO 2000 instrument by using Daicel chiral columns with hexane/*i*-propanol as the eluent at 220 nm. Substrates were prepared according to the literature procedure.

2. General procedure for Rh-catalyzed asymmetric arylation reaction

A solution of substrate **1** (0.10 mmol), **2** (0.20 mmol), $[Rh(coe)_2Cl]_2$ (2.5 mol%, 1.8 mg, 0.005 mmol of [Rh]), ligand **L12** (5.5 mol%, 2.9 mg, 0.0055 mmol) in 1 mL of toluene was stirred at ambient temperature for 30 min under argon atmosphere and then aqueous K_3PO_4 (0.10 mL, 1.0 M, 0.10 mmol) was added to the mixture. After being stirred at ambient temperature for 12 h, the solvent was evaporated in vacuo. The desired product **3** was afforded after purification of the residue by column chromatography (PE/EA = 5/1).

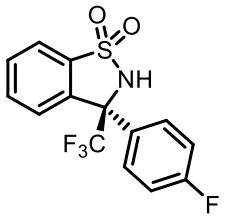


(*R*)-3-(p-tolyl)-3-(trifluoromethyl)-2,3-dihydrobenzo[*d*]isothiazole 1,1-dioxide (**3a**)
White solid (98% yield); $[\alpha]_D^{20}$ -6.9 (*c* 1.1, $CHCl_3$) for 98% ee; ^{1}H NMR (400 MHz, $CDCl_3$) *δ* 7.91-7.88 (m, 1H), 7.71-7.68 (m, 2H), 7.47-7.46 (m, 1H), 7.37 (d, *J* = 8.0 Hz, 2H), 7.20 (d, *J* = 8.0 Hz, 2H), 5.15 (s, 1H), 2.35 (s, 3H); ^{13}C NMR (126 MHz, $CDCl_3$) *δ* 140.4, 135.8, 135.6, 134.2, 132.6, 131.6, 130.4, 127.2, 126.7, 124.8 (q, *J* = 283.25Hz), 122.1, 69.7 (q, *J* = 30.25 Hz), 21.4; ^{19}F NMR (375 MHz, $CDCl_3$) *δ* -72.2 (s, 3F); HRMS-EI calcd for $C_{15}H_{12}O_2NF_3S$ (M^+) 327.0535, found 327.0535.



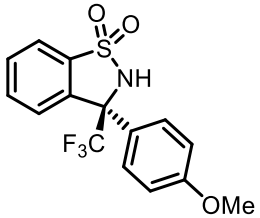
(*R*)-3-phenyl-3-(trifluoromethyl)-2,3-dihydrobenzo[*d*]isothiazole 1,1-dioxide (**3b**)

White solid (93% yield); $[\alpha]_D^{20}$ -15.9 (*c* 1.0, $CHCl_3$) for 97% ee; ^1H NMR (400 MHz, $CDCl_3$) δ 7.92-7.90 (m, 1H), 7.72-7.70 (m, 2H), 7.52-7.47 (m, 3H), 7.44-7.41 (m, 3H), 5.15 (s, 1H); ^{13}C NMR (126 MHz, $CDCl_3$) δ 135.7, 135.6, 135.4, 134.3, 131.7, 130.2, 129.8, 127.3, 126.8, 124.7 (q, J = 287.5 MHz), 122.2, 69.9 (q, J = 30.25 Hz); ^{19}F NMR (375 MHz, $CDCl_3$) δ -72.1 (s, 3F); HRMS-EI calcd for $C_{14}H_{10}O_2NF_3S$ (M^+) 313.0379, found 313.0376.



(*R*)-3-(4-fluorophenyl)-3-(trifluoromethyl)-2,3-dihydrobenzo[*d*]isothiazole 1,1-dioxide (**3c**).

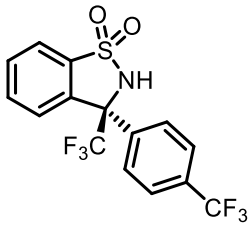
White solid (91% yield); $[\alpha]_D^{20}$ -10.9 (*c* 1.0, $CHCl_3$) for 96% ee; ^1H NMR (400 MHz, $CDCl_3$) δ 7.92-7.90 (m, 1H), 7.73-7.71 (m, 2H), 7.53-7.50 (m, 2H), 7.48-7.46 (m, 1H), 7.12-7.08 (m, 2H), 5.23 (s, 1H); ^{13}C NMR (126 MHz, $CDCl_3$) δ 163.5 (d, J = 208.38 Hz), 135.6, 135.1, 134.4, 131.9, 131.4 (d, J = 2.88 Hz), 129.6 (d, J = 7.00 Hz), 126.6, 124.7 (q, J = 236.35 Hz), 122.3, 116.8(d, J = 18.12 Hz), 69.4 (q, J = 25.62 Hz); ^{19}F NMR (375 MHz, $CDCl_3$) δ -72.4 (s, 3F), -110.6 (m, 1F); HRMS-EI calcd for $C_{14}H_9O_2NF_4S$ (M^+) 331.0285, found 331.0282.



(*R*)-3-(4-methoxyphenyl)-3-(trifluoromethyl)-2,3-dihydrobenzo[*d*]isothiazole 1,1-dioxide (**3d**).

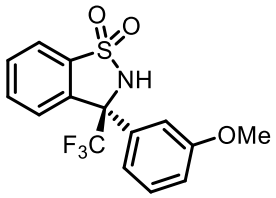
White solid (91% yield); $[\alpha]_D^{20}$ 1.3 (*c* 0.8, $CHCl_3$) for 97% ee; ^1H NMR (400 MHz,

$CDCl_3$) δ 7.91-7.88 (m, 1H), 7.71-7.69 (m, 2H), 7.48-7.46 (m, 1H), 7.40 (d, J = 8.4 Hz, 2H), 6.90 (d, J = 8.8 Hz, 2H), 5.13 (s, 1H), 3.81 (s, 3H); ^{13}C NMR (126 MHz, $CDCl_3$) δ 160.8, 135.8, 135.7, 134.2, 131.6, 128.8, 127.4, 126.7, 124.8 (q, J = 283.12 Hz), 122.1, 115.0, 69.6 (q, J = 30.25 Hz), 55.7; ^{19}F NMR (375 MHz, $CDCl_3$) δ -72.3 (s, 3F); HRMS-EI calcd for $C_{15}H_{12}O_3NF_3S$ (M^+) 343.0485, found 343.0490.



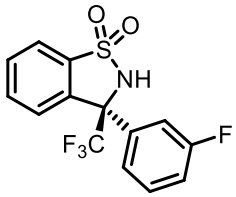
(*R*)-3-(naphthalen-2-yl)-3-(trifluoromethyl)-2,3-dihydrobenzo[*d*]isothiazole 1,1-dioxide (**3e**).

Yellow solid (95% yield); $[\alpha]_D^{20}$ -24.8 (*c* 0.5, $CHCl_3$) for 98% ee; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.93-7.91 (m, 1H), 7.76 -7.67 (m, 6H), 7.49-7.48 (d, J = 5.2 Hz, 1H), 5.55 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 139.3, 135.5, 134.5, 134.4, 132.3 (q, J = 32.9 Hz), 132.1, 128.0 (q, J = 5.5 Hz), 126.6 (q, J = 3.8 Hz), 126.5 (q, J = 286.3 Hz), 126.4 (d, J = 1.1 Hz), 124.5 (q, J = 283.5 Hz), 122.4, 26.4 (q, J = 30.2 Hz); ^{19}F NMR (375 MHz, $CDCl_3$) δ -63.11 (s, 3F), -72.21 (s, 3F); HRMS-EI calcd for $C_{15}H_9O_2NF_6S$ (M^+) 381.0258 found 381.0255.



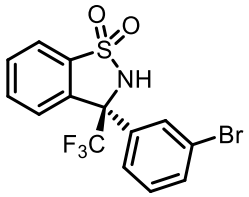
(*R*)-3-(3-methoxyphenyl)-3-(trifluoromethyl)-2,3-dihydrobenzo[*d*]isothiazole 1,1-dioxide (**3f**).

White oil (82% yield); $[\alpha]_D^{20}$ -17.4 (*c* 0.7, $CHCl_3$) for 98% ee; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.88-7.86 (m, 1H), 7.69-7.67 (m, 2H), 7.49-7.48 (m, 1H), 7.31 (t, J = 7.6 Hz, 1H), 7.09-7.05 (m, 2H), 6.91 (d, J = 8.0 Hz, 1H), 5.45 (s, 1H), 3.75 (s, 3H); ^{13}C NMR (126 MHz, $CDCl_3$) δ 160.4, 136.9, 135.6, 135.1, 134.2, 131.7, 130.8, 126.7, 124.7 (q, J = 283.38 Hz), 122.1, 119.3, 115.0, 113.8, 69.7 (q, J = 30.25 Hz), 55.7; ^{19}F NMR (375 MHz, $CDCl_3$) δ -72.1 (s, 3F); HRMS-EI calcd for $C_{15}H_{12}O_3NF_3S$ (M^+) 343.0485, found 343.0485.



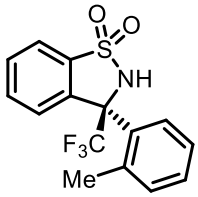
(*R*)-3-(3-fluorophenyl)-3-(trifluoromethyl)-2,3-dihydrobenzo[*d*]isothiazole 1,1-dioxide (**3g**).

Yellow oil (87% yield); $[\alpha]_D^{20}$ -18.6 (*c* 0.5, $CHCl_3$) for 95% ee; ^1H NMR (400 MHz, $CDCl_3$) δ 7.92-7.90 (m, 1H), 7.74-7.71 (m, 2H), 7.51-7.49 (m, 1H), 7.43-7.37 (m, 1H), 7.32 (d, *J* = 8.0 Hz, 1H), 7.27 (d, *J* = 8.0 Hz, 1H), 7.14-7.10 (m, 1H), 5.45 (s, 1H); ^{13}C NMR (126 MHz, $CDCl_3$) δ 163.2 (d, *J* = 247.12 Hz), 137.7 (d, *J* = 7.12 Hz), 135.6, 134.6, 134.4, 131.9, 131.5 (d, *J* = 8.12 Hz), 126.5, 124.5 (q, *J* = 283.5 Hz), 123.1, 122.3, 117.3 (d, *J* = 20.75 Hz), 115.0 (d, *J* = 24.38 Hz), 69.4 (q, *J* = 30.62 Hz); ^{19}F NMR (375 MHz, $CDCl_3$) δ -72.3 (s, 3F), -109.7 (m, 1F); HRMS-EI calcd for $C_{14}H_9O_2NF_4S$ (M^+) 331.0285, found 331.0287.



(*R*)-3-(3-bromophenyl)-3-(trifluoromethyl)-2,3-dihydrobenzo[*d*]isothiazole 1,1-dioxide (**3h**).

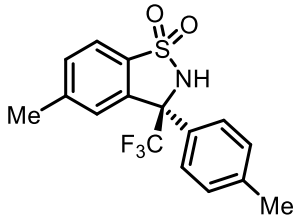
White solid (82% yield); $[\alpha]_D^{20}$ -24.1 (*c* 0.9, $CHCl_3$) for 98% ee; ^1H NMR (400 MHz, $CDCl_3$) δ 7.93-7.90 (m, 1H), 7.74-7.72 (m, 2H), 7.68 (s, 1H), 7.56 (dq, *J* = 8.0, 0.8 Hz, 1H), 7.50-7.49 (m, 1H), 7.48-7.46 (m, 1H), 7.29 (t, *J* = 8.0 Hz, 1H), 5.30 (s, 1H); ^{13}C NMR (126 MHz, $CDCl_3$) δ 137.6, 135.7, 134.5, 134.4, 133.5, 132.0, 131.3, 130.4, 126.6, 126.1, 124.5 (q, *J* = 283.5 Hz), 123.8, 122.4, 69.3 (q, *J* = 30.62 Hz); ^{19}F NMR (375 MHz, $CDCl_3$) δ -72.2 (s, 3F); HRMS-EI calcd for $C_{14}H_9O_2NBrF_3S$ (M^+) 390.9484, found 390.9464.



(*R*)-3-(o-tolyl)-3-(trifluoromethyl)-2,3-dihydrobenzo[*d*]isothiazole 1,1-dioxide (**3i**).

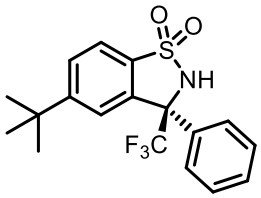
White solid (81% yield); $[\alpha]_D^{20}$ -44.8 (*c* 0.8, $CHCl_3$) for 90% ee; ^1H NMR (400 MHz,

$CDCl_3$) δ 7.91 (d, J = 8.0 Hz, 1H), 7.79-7.77 (m, 1H), 7.71 (m, 1H), 7.65 (m, 1H), 7.36-7.29 (m, 2H), 7.27-7.25 (m, 1H), 7.16 (d, J = 6.8 Hz, 1H), 5.15 (s, 1H), 1.79 (s, 3H); ^{13}C NMR (126 MHz, $CDCl_3$) δ 138.5, 136.8, 135.9, 134.6, 134.2, 131.6, 131.5, 130.5, 128.7 (q, J = 4.38 Hz), 126.6, 126.1, 125.1 (q, J = 285.50 Hz), 122.1, 70.3 (q, J = 29.00 Hz), 21.0; ^{19}F NMR (375 MHz, $CDCl_3$) δ -70.4 (s, 3F); HRMS-EI calcd for $C_{15}H_{12}O_2NF_3S$ (M^+) 327.0535, found 327.0537.



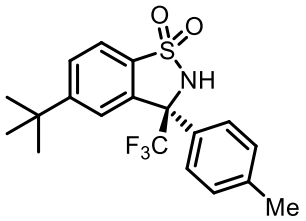
(*R*)-5-methyl-3-(p-tolyl)-3-(trifluoromethyl)-2,3-dihydrobenzo[*d*]isothiazole 1,1-dioxide (**3j**).

White solid (94% yield); $[\alpha]_D^{20}$ 41.3 (*c* 0.6, $CHCl_3$) for 98% ee; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.76 (d, J = 8.0 Hz, 1H), 7.48 (d, J = 8.0 Hz, 1H), 7.38 (d, J = 8.0 Hz, 2H), 7.22-7.20 (m, 3H), 5.15 (s, 1H), 2.44 (s, 3H), 2.35 (s, 3H); ^{13}C NMR (126 MHz, $CDCl_3$) δ 145.5, 140.2, 135.9, 133.0, 132.8, 132.6, 130.3, 127.2, 126.7, 124.8 (q, J = 236.12 Hz), 121.80, 69.6 (q, J = 25.12 Hz), 22.2, 21.4; ^{19}F NMR (375 MHz, $CDCl_3$) δ -72.1 (s, 3F); HRMS-EI calcd for $C_{16}H_{14}O_2NF_3S$ (M^+) 341.0692 , found 341.0692.



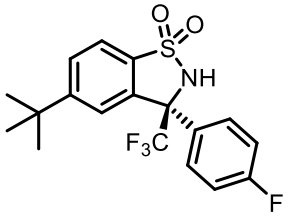
(*R*)-5-(tert-butyl)-3-phenyl-3-(trifluoromethyl)-2,3-dihydrobenzo[*d*]isothiazole 1,1-dioxide (**3k**).

White solid (86% yield); $[\alpha]_D^{20}$ 58.7 (*c* 1.0, $CHCl_3$) for 98% ee; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.81 (d, J = 8.4 Hz, 1H), 7.73 (dd, J = 8.4, 1.2 Hz, 1H), 7.52-7.50 (m, 2H), 7.41-7.40 (m, 4H), 5.27 (s, 1H), 1.31 (s, 9H); ^{13}C NMR (126 MHz, $CDCl_3$) δ 158.8, 135.8, 135.4, 133.0, 130.1, 129.7, 129.3, 127.3, 124.6 (q, J = 283.38 Hz), 123.2, 121.7, 69.9 (q, J = 30.12 Hz), 35.9, 31.4; ^{19}F NMR (375 MHz, $CDCl_3$) δ -72.1 (s, 3F); HRMS-EI calcd for $C_{18}H_{18}O_2NF_3S$ (M^+) 369.1005, found 369.1023.



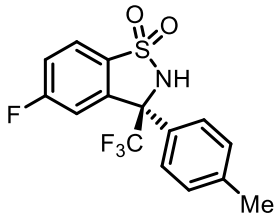
(*R*)-5-(tert-butyl)-3-(p-tolyl)-3-(trifluoromethyl)-2,3-dihydrobenzo[*d*]isothiazole 1,1-dioxide (**3l**).

Yellow solid (89% yield); $[\alpha]_D^{20}$ 71.6 (*c* 1.1, $CHCl_3$) for 97% ee; ^1H NMR (400 MHz, $CDCl_3$) δ 7.80 (d, *J* = 8.4 Hz, 1H), 7.72 (dd, *J* = 8.4, 1.6 Hz, 1H), 7.41 (s, 1H), 7.37 (d, *J* = 8.0 Hz, 2H), 7.21 (d, *J* = 8.0 Hz, 2H), 5.24 (s, 1H), 2.35 (s, 3H), 1.31 (s, 9H); ^{13}C NMR (126 MHz, $CDCl_3$) *δ* 158.7, 140.3, 135.6, 133.1, 132.8, 130.4, 129.2, 127.2, 124.9 (q, *J* = 283.38 Hz), 123.2, 121.6, 69.9 (q, *J* = 30.12 Hz), 35.9, 31.4, 21.4; ^{19}F NMR (375 MHz, $CDCl_3$) *δ* -72.2 (s, 3F); HRMS-EI calcd for $C_{19}H_{20}O_2NF_3S$ (M^+) 383.1161, found 383.1161.



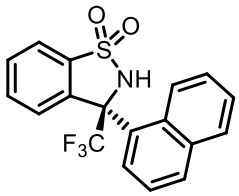
(*R*)-5-(tert-butyl)-3-(4-fluorophenyl)-3-(trifluoromethyl)-2,3-dihydrobenzo[*d*]isothiazole 1,1-dioxide (**3m**).

Yellow solid (89% yield); $[\alpha]_D^{20}$ 7.0 (*c* 1.1, $CHCl_3$) for 99% ee; ^1H NMR (400 MHz, $CDCl_3$) *δ* 7.81 (d, *J* = 8.0 Hz, 1H), 7.74 (dd, *J* = 8.4, 1.6 Hz, 1H), 7.53 - 7.49 (m, 2H), 7.39 (s, 1H), 7.10 (t, *J* = 8.4 Hz, 2H), 5.25 (s, 1H), 1.32 (s, 9H); ^{13}C NMR (126 MHz, $CDCl_3$) *δ* 163.5 (d, *J* = 249.50 Hz), 158.9, 135.2, 132.9, 131.6 (d, *J* = 3.375 Hz), 129.6 (d, *J* = 6.3 Hz), 129.4, 124.8 (q, *J* = 283.25 Hz), 123.0, 121.8, 116.8 (d, *J* = 21.75 Hz), 69.4 (q, *J* = 30.25 Hz), 36.0, 31.4; ^{19}F NMR (375 MHz, $CDCl_3$) *δ* -72.3 (s, 3F), -110.7 (m, 1F); HRMS-EI calcd for $C_{18}H_{17}O_2NF_4S$ (M^+) 387.0911, found 387.0905.



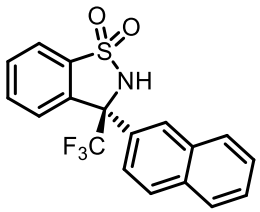
(*R*)-5-fluoro-3-(p-tolyl)-3-(trifluoromethyl)-2,3-dihydrobenzo[*d*]isothiazole 1,1-dioxide (**3n**).

Yellow solid (58% yield); $[\alpha]_D^{20}$ -7.500 (*c* 0.8, $CHCl_3$) for 99% ee; ^1H NMR (400 MHz, $CDCl_3$) δ 7.90 - 7.87 (dd, *J* = 8.8, 4.8 Hz, 1H), 7.41-7.37 (m, 3H), 7.24 - 7.22 (d, *J* = 8.0 Hz, 2H), 7.12 - 7.10 (d, *J* = 8.0 Hz, 1H), 5.23 (s, 1H), 2.36 (s, 3H); ^{13}C NMR (126 MHz, $CDCl_3$) δ 166.0 (d, *J* = 255.3 Hz), 140.7, 136.7 (d, *J* = 9.4 Hz), 132.0, 131.8, 130.6, 127.1, 124.6 (q, *J* = 285.3 Hz), 124.4 (d, *J* = 9.7 Hz), 119.8 (d, *J* = 23.9 Hz), 114.0 (d, *J* = 26.5 Hz), 69.4 (q, *J* = 30.3 Hz), 21.4; ^{19}F NMR (375 MHz, $CDCl_3$) δ -72.2 (s, 3F), -102.0 (m, 1F); HRMS-ESI calcd for $C_{15}H_{10}O_2NF_4S$ ($[M-H]^-$) 344.0368, found 344.0372.



(*R*)-3-(naphthalen-1-yl)-3-(trifluoromethyl)-2,3-dihydrobenzo[*d*]isothiazole 1,1-dioxide (**3o**).

Yellow solid (60% yield); $[\alpha]_D^{20}$ -114.8 (*c* 0.8, $CHCl_3$) for 96% ee; ^1H NMR (400 MHz, $CDCl_3$) δ 8.06 - 7.97 (m, 3H), 7.88 (d, *J* = 8.0 Hz, 1H), 7.72 (t, *J* = 7.2 Hz, 1H), 7.60 - 7.49 (m, 3H), 7.43 (t, *J* = 7.2 Hz, 1H), 7.31 (d, *J* = 8.4 Hz, 1H), 7.22 (d, *J* = 7.6 Hz, 1H), 5.44 (s, 1H); ^{13}C NMR (126 MHz, $CDCl_3$) δ 136.9, 136.4, 135.5, 134.3, 132.4, 131.7, 130.4, 129.9, 128.4 (q, *J* = 4.25 Hz), 127.8, 127.4, 126.42, 126.37, 125.1 (q, *J* = 285.25 Hz), 124.7, 123.8, 122.5, 71.1 (q, *J* = 29.00 Hz); ^{19}F NMR (375 MHz, $CDCl_3$) δ -70.5 (s, 3F); HRMS-EI calcd for $C_{18}H_{12}O_2NF_3S$ (M^+) 363.0535, found 363.0538.



(*R*)-3-(naphthalen-2-yl)-3-(trifluoromethyl)-2,3-dihydrobenzo[*d*]isothiazole 1,1-dioxide (**3p**).

Yellow solid (81% yield); $[\alpha]_D^{20}$ -84.0 (*c* 1.1, $CHCl_3$) for 98% ee; ^1H NMR (400 MHz, $CDCl_3$) δ 8.09 (s, 1H), 7.93 (dd, *J* = 8.4, 1.6 Hz, 1H), 7.89 -7.82 (m, 3H), 7.74-7.67 (m, 2H), 7.59-7.55 (m, 2H), 7.48 (d, *J* = 7.6 Hz, 1H), 7.41 (d, *J* = 8.0 Hz, 1H), 5.34 (s, 1H);

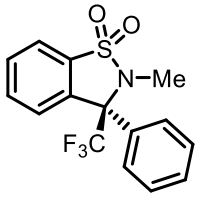
^{13}C NMR (126 MHz, $CDCl_3$) δ 135.8, 135.4, 134.3, 133.5, 133.0, 132.4, 131.8, 130.1, 129.1, 128.1, 127.9, 127.6, 127.1, 126.8, 124.9 (q, J = 283.37 Hz), 124.0, 122.2, 70.1 (q, J = 30.50 Hz); ^{19}F NMR (375 MHz, $CDCl_3$) δ -71.8 (s, 3F); HRMS-EI calcd for $C_{18}H_{12}O_2NF_3S$ (M^+) 363.0535, found 363.0537.

3. Gram-scale synthesis of 3b

A solution of substrate **1a** (4.0 mmol, 1.0 g), phenyl boroxine **2b** (8.0 mmol), $[Rh(coe)_2Cl]_2$ (2.5 mol%, 71.8 mg, 0.02 mmol of [Rh]), ligand **L12** (5.5 mol%, 116.6 mg, 0.022 mmol) in 40 mL of toluene was stirred at ambient temperature for 30 min under argon atmosphere and then aqueous K_3PO_4 (4.0 mL, 1.0 M, 4.0 mmol) was added to the mixture. After being stirred at ambient temperature for 12 h, the solvent was evaporated in vacuo. The residue was purified by column chromatography (PE/EA = 5/1) to afford **3b** (1.1 g, 88% yield) as a white solid.

4. The synthesis of 4a

MeI (0.15 mmol, 21.3 mg) was added to a solution of substrate **3b** (0.05 mmol, 16 mg) and anhydrous K_2CO_3 (0.125 mmol, 17.3 mg) in 1 mL MeCN under argon atmosphere. After being stirred at ambient temperature for 4 hours, the mixture was evaporated in vacuo. The residue was purified by column chromatography (PE/EA = 5/1) to afford **4a** (1.6 mg, 99% yield) as a white solid.



(*R*)-2-methyl-3-phenyl-3-(trifluoromethyl)-2,3-dihydrobenzo[*d*]isothiazole 1,1-dioxide (**4a**).

White solid (99% yield); $[\alpha]_D^{20}$ -76.9 (*c* 1.0, $CHCl_3$) for 97% ee; ^1H NMR (400 MHz, $CDCl_3$) δ 7.92 (d, J = 7.6 Hz, 2H), 7.67 - 7.64 (t, J = 7.6 Hz, 1H), 7.62 - 7.58 (t, J = 7.2 Hz, 1H), 7.40 - 7.38 (m, 5H), 7.31 - 7.29 (d, J = 7.2 Hz, 1H), 2.76 (s, 3H); ^{13}C NMR (126 MHz, $CDCl_3$) δ 135.1, 134.3, 133.8, 133.1, 131.3, 129.8, 129.6, 127.9, 126.6, 125.0 (q, J = 286.70 Hz), 121.8, 72.6 (q, J = 29.00 Hz), 25.9; ^{19}F NMR (375 MHz, $CDCl_3$) δ -68.67 (s, 3F); HRMS-ESI calcd for $C_{15}H_{13}O_2NF_3S$ ($[M+H]^+$) 328.0619, found 328.0614.

5. Crystal structure of compound 3j

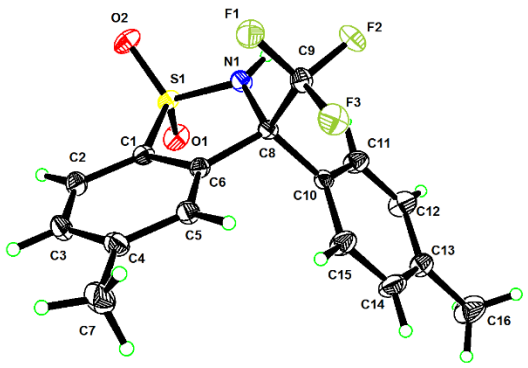


Figure S1. ORTEP representation of compound **3j**

```
Bond precision:  C-C = 0.0036 A          Wavelength=0.71073

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                 alpha=90        beta=90           gamma=90
Temperature:     173 K

                 Calculated                Reported
Volume           1537.7(3)                 1537.7(3)
Space group      P 21 21 21                P 21 21 21
Hall group       P 2ac 2ab                 P 2ac 2ab
Moiety formula   C16 H14 F3 N O2 S         C16 H14 F3 N O2 S
Sum formula      C16 H14 F3 N O2 S         C16 H14 F3 N O2 S
Mr               341.34                    341.34
Dx,g cm-3        1.474                     1.474
Z                4                         4
Mu (mm-1)        0.251                     0.251
F000             704.0                     704.0
F000'            704.93
h,k,lmax         11,13,21                  11,13,21
Nref             3543[ 2034]               3519
Tmin,Tmax        0.939,0.963               0.663,0.746
Tmin'            0.914

Correction method= # Reported T Limits: Tmin=0.663 Tmax=0.746
AbsCorr = MULTI-SCAN

Data completeness= 1.73/0.99       Theta(max)= 27.516

R(reflections)= 0.0344( 3296)      wR2(reflections)= 0.0923( 3519)

S = 1.050                  Npar= 214
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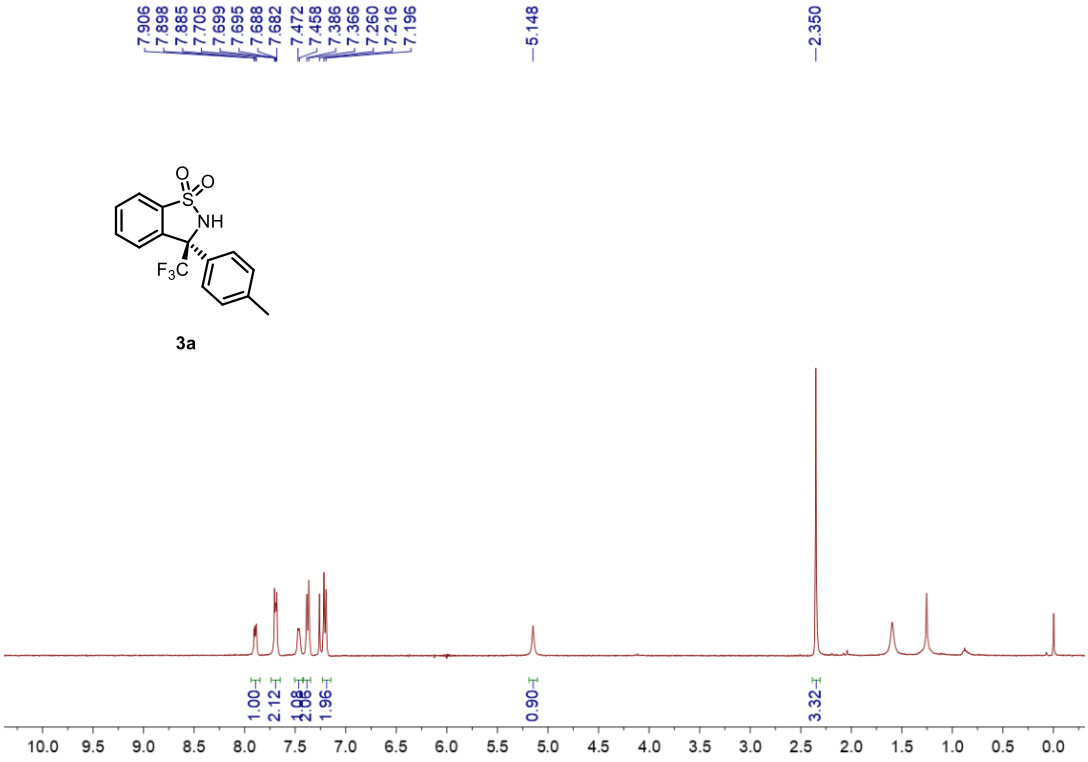
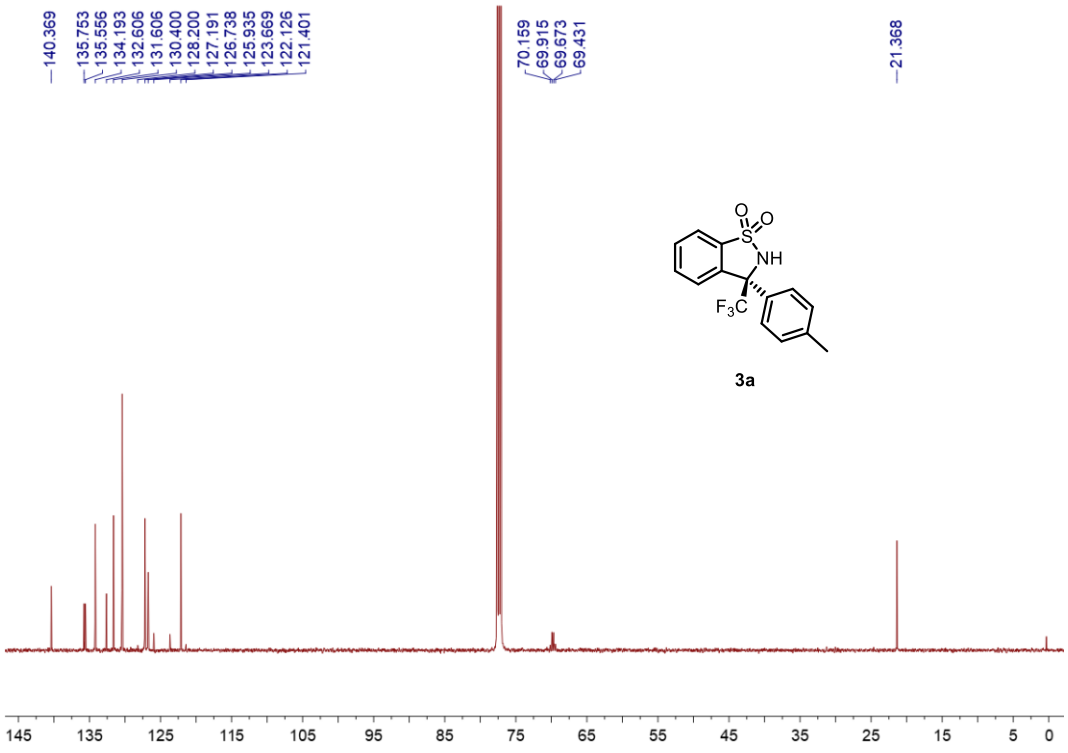
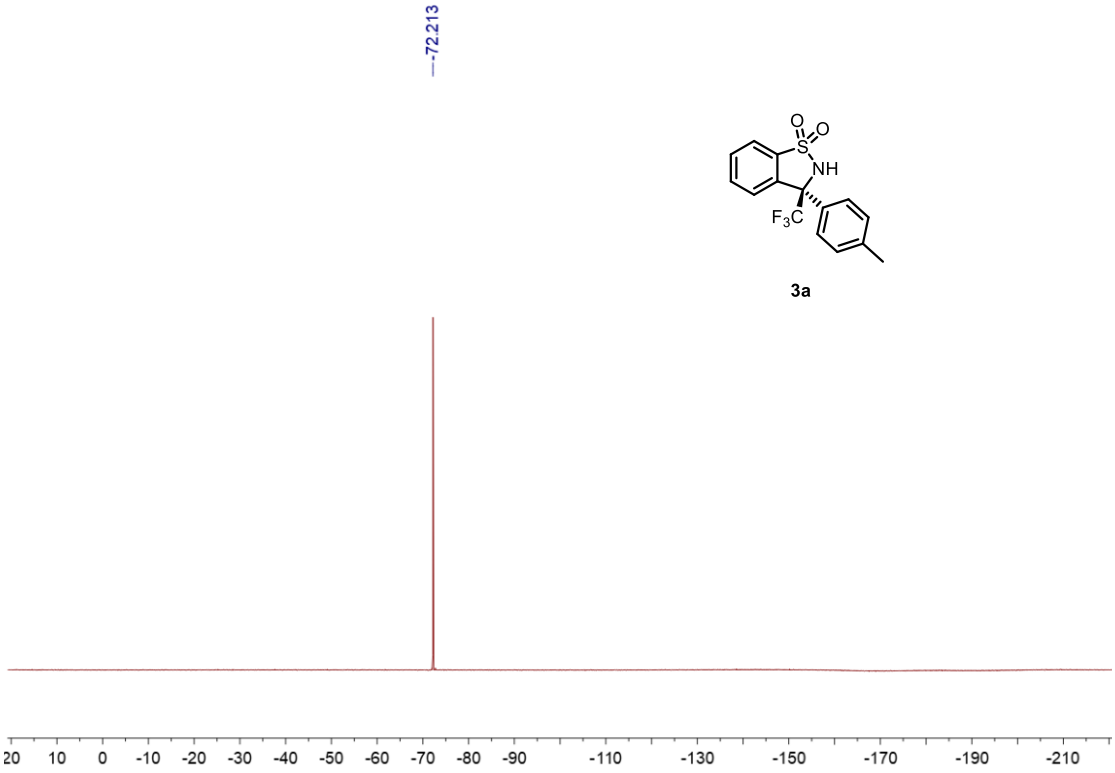
Figure S2. Crystal structure parameters

6. NMR spectra



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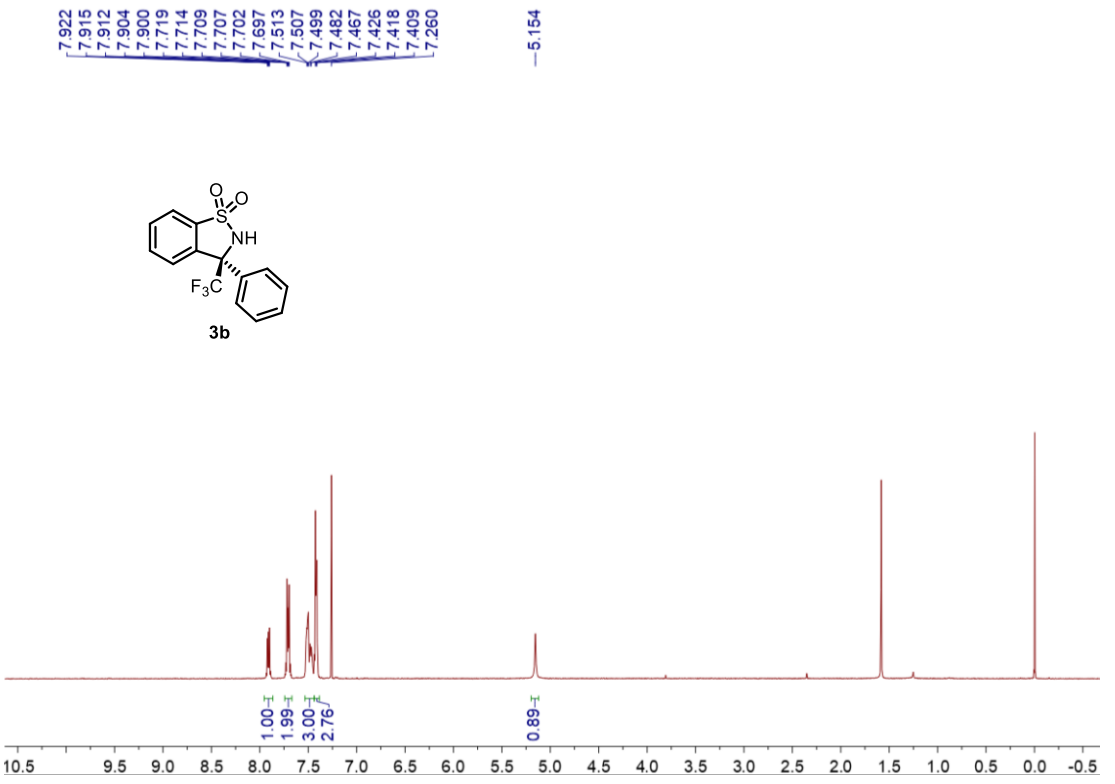
3a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7.507
7.499
7.482
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1.99
3.00
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0.89
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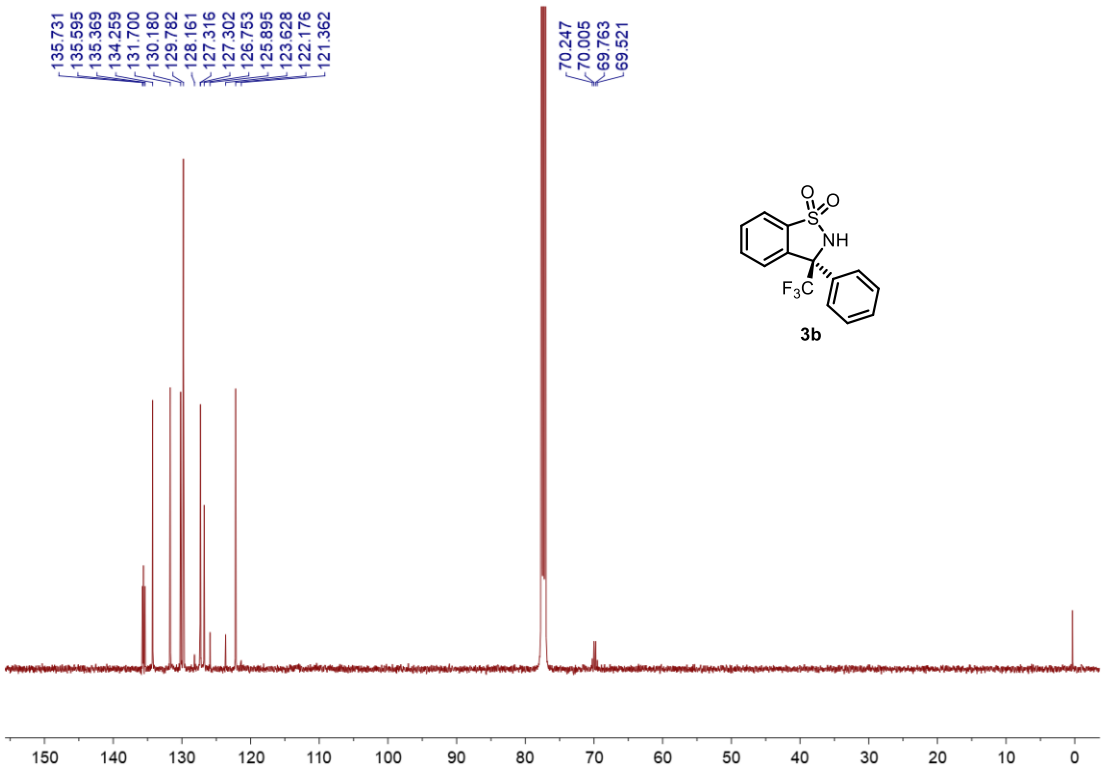
3b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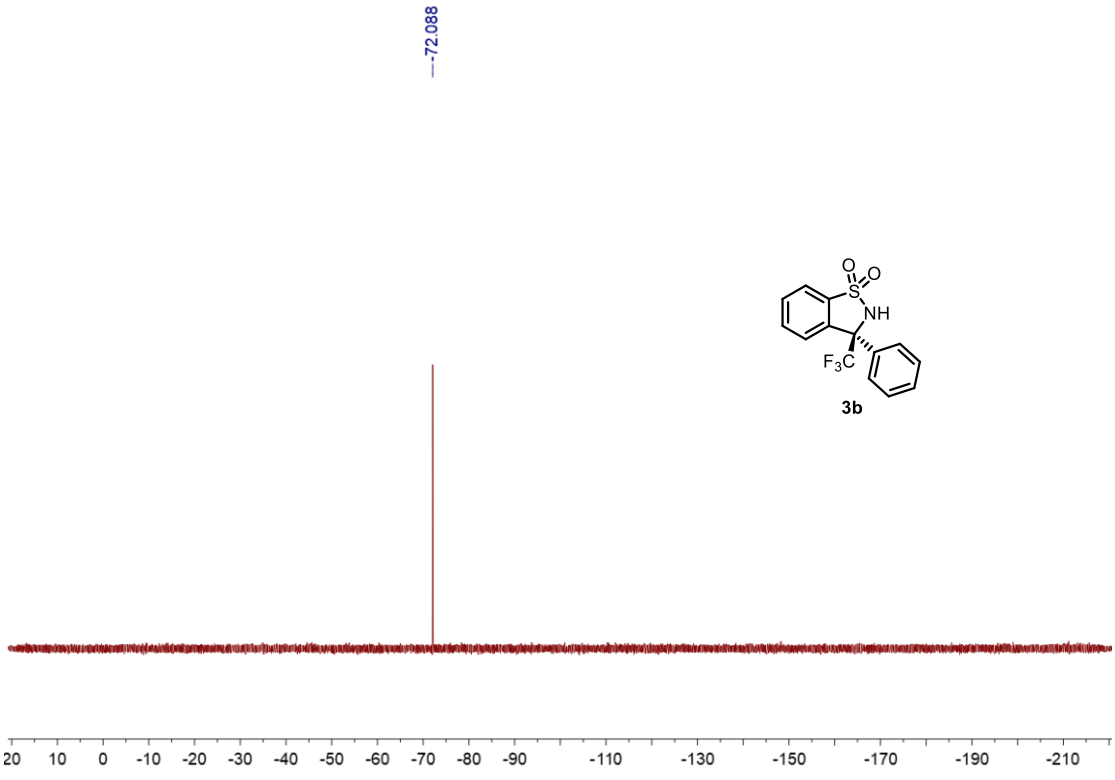
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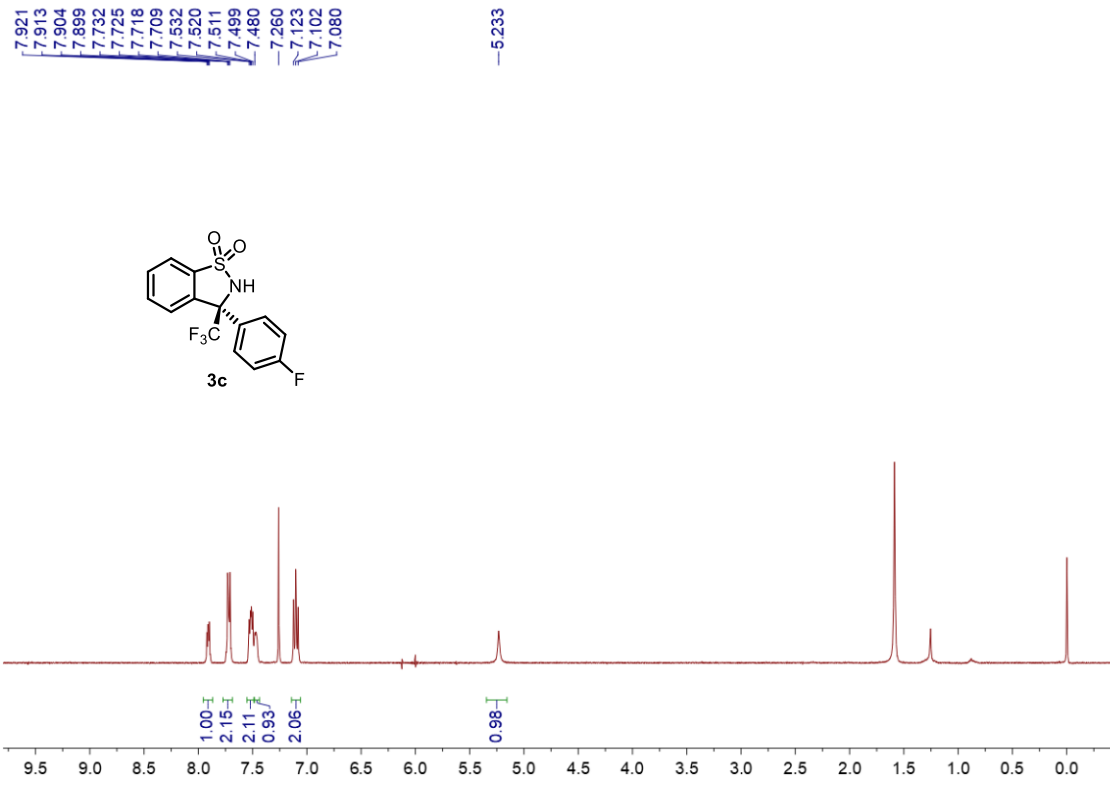
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0.98
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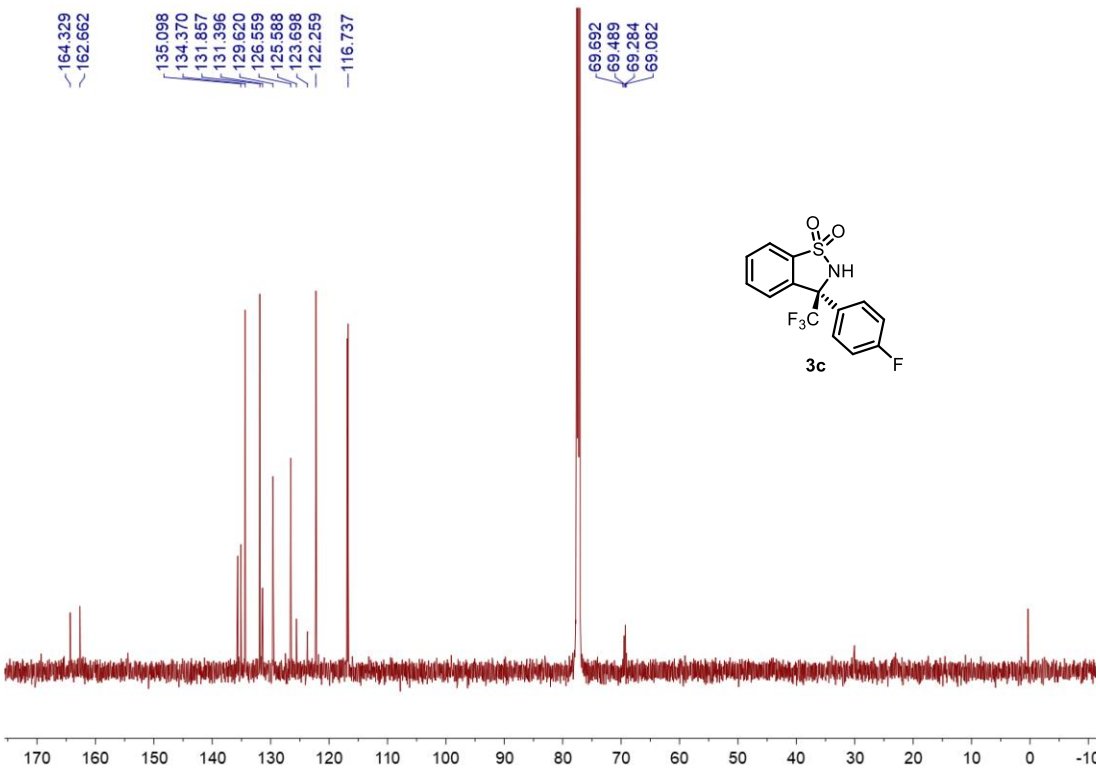
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F
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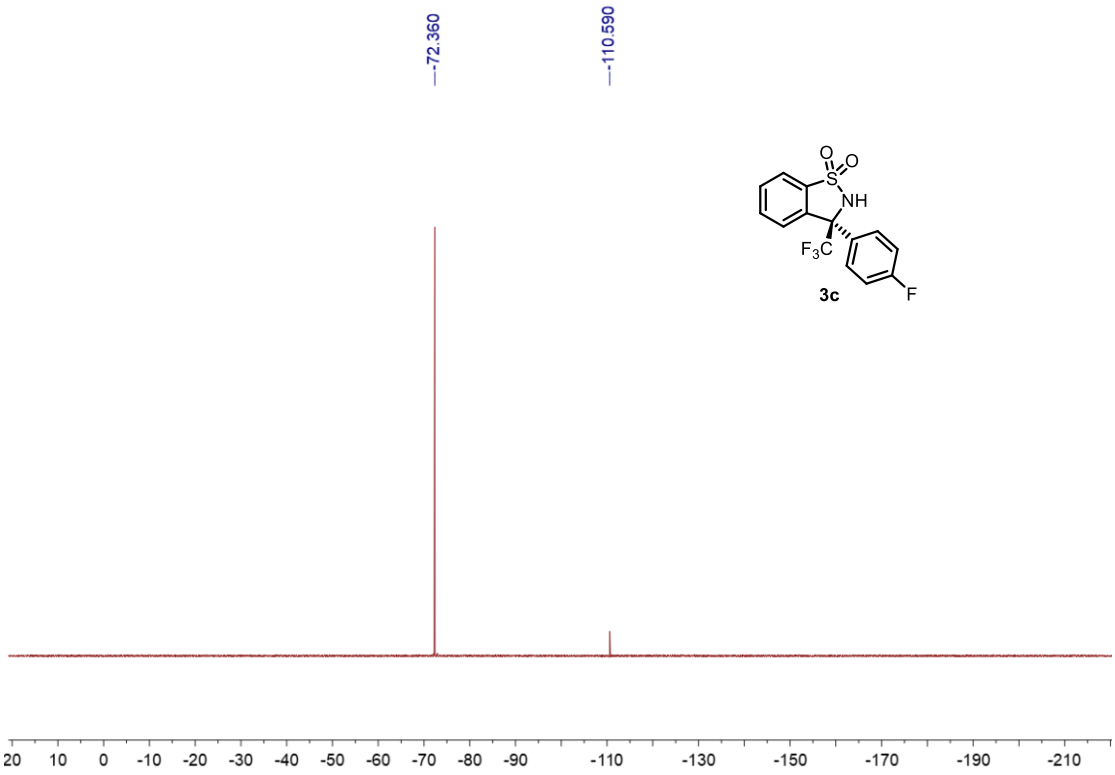
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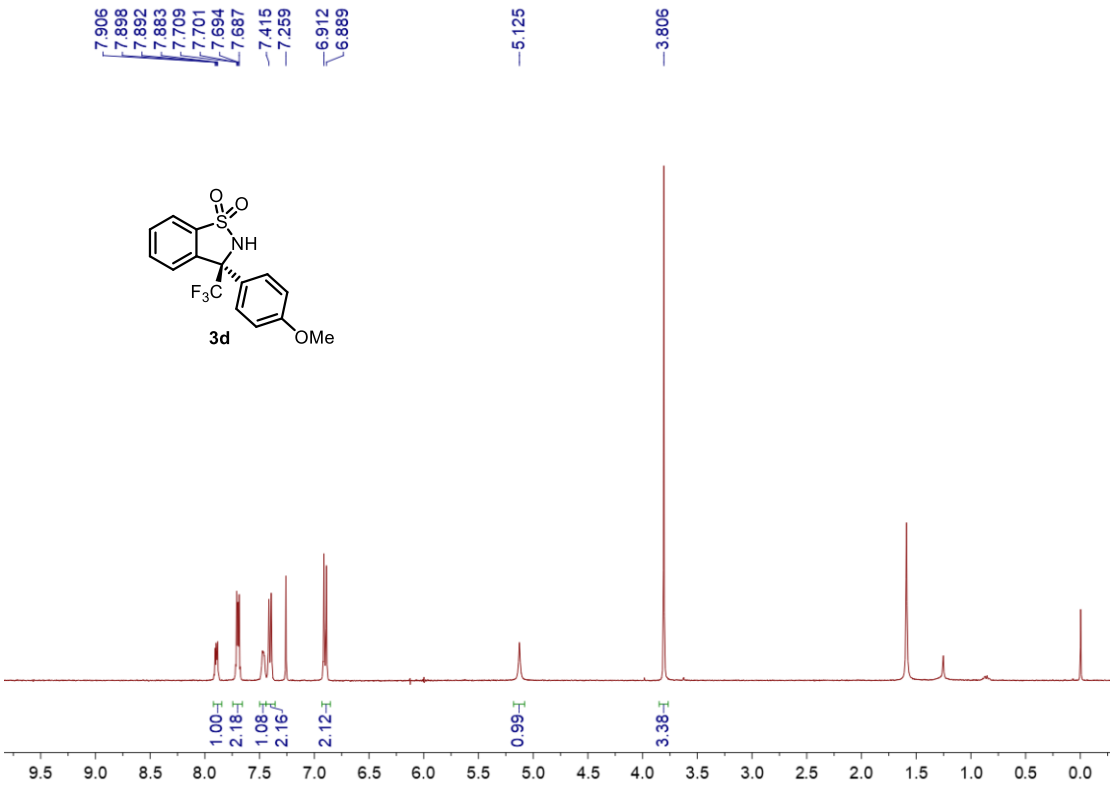
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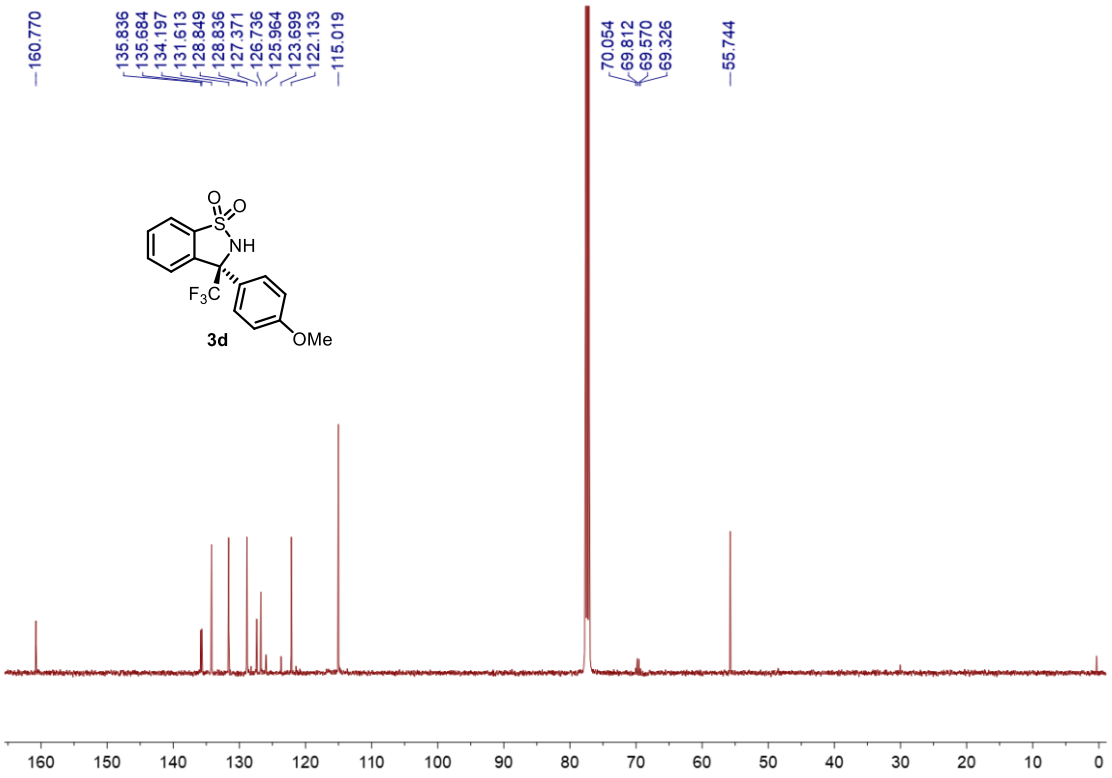
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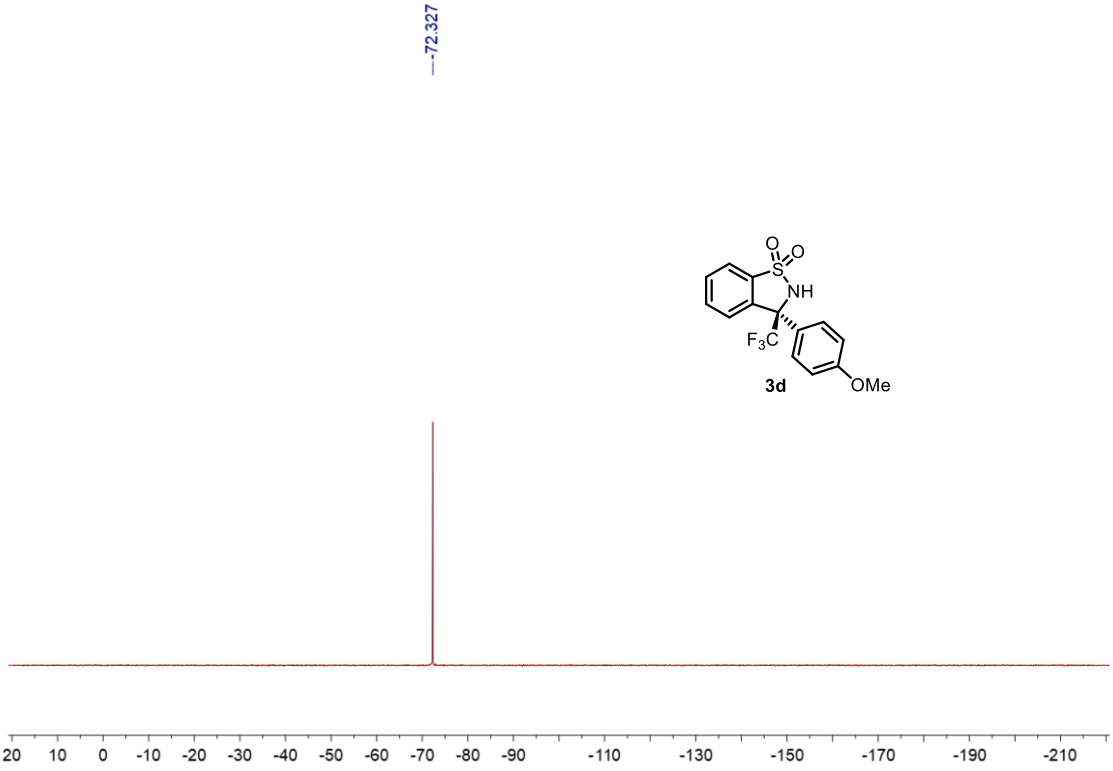
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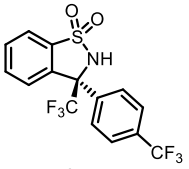
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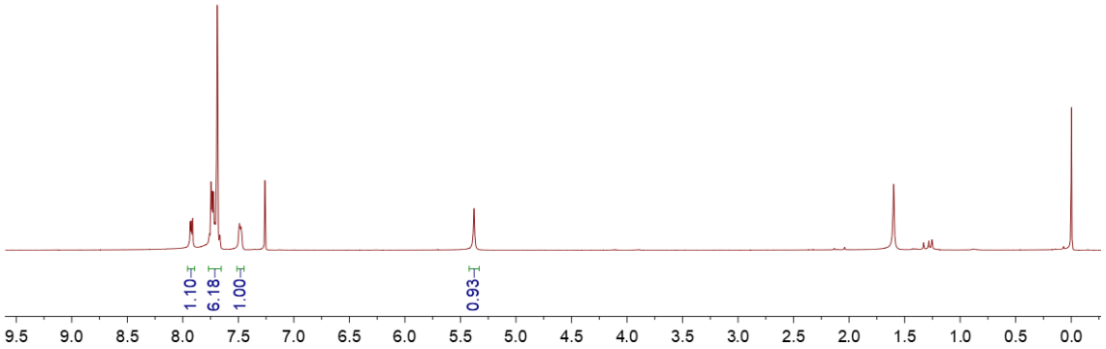
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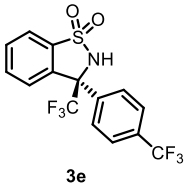
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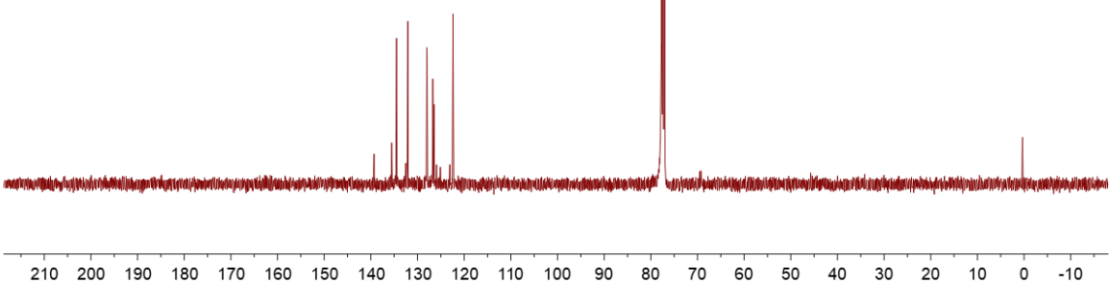
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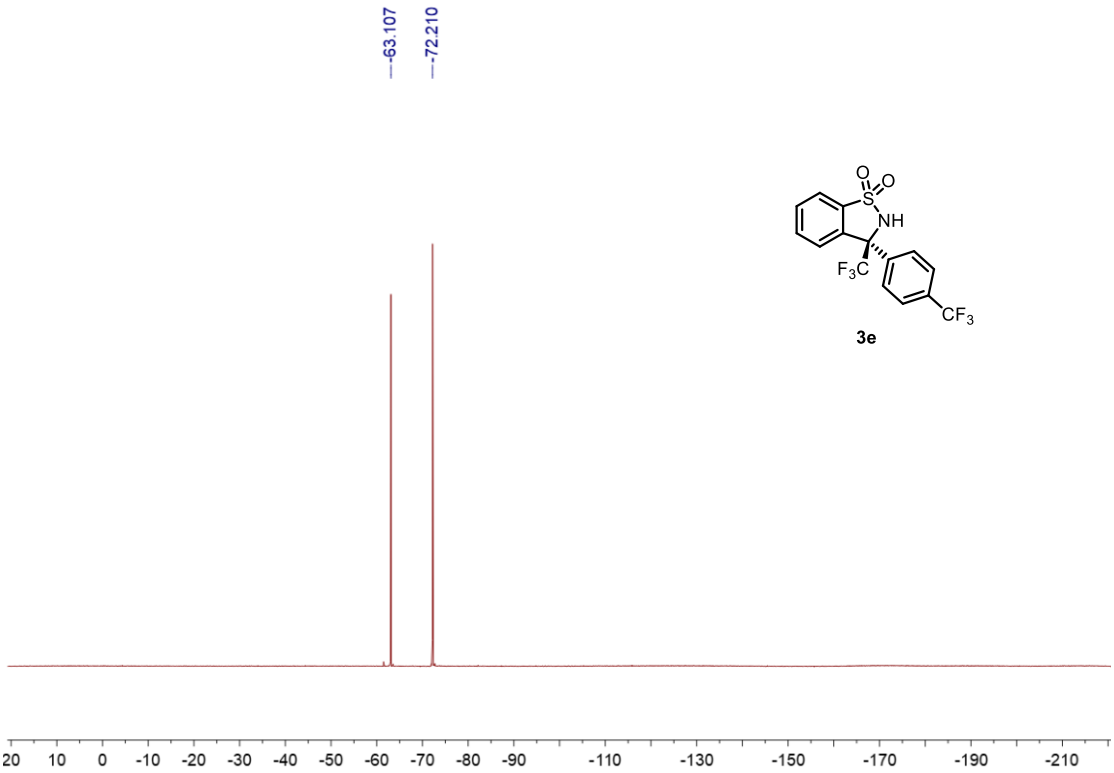
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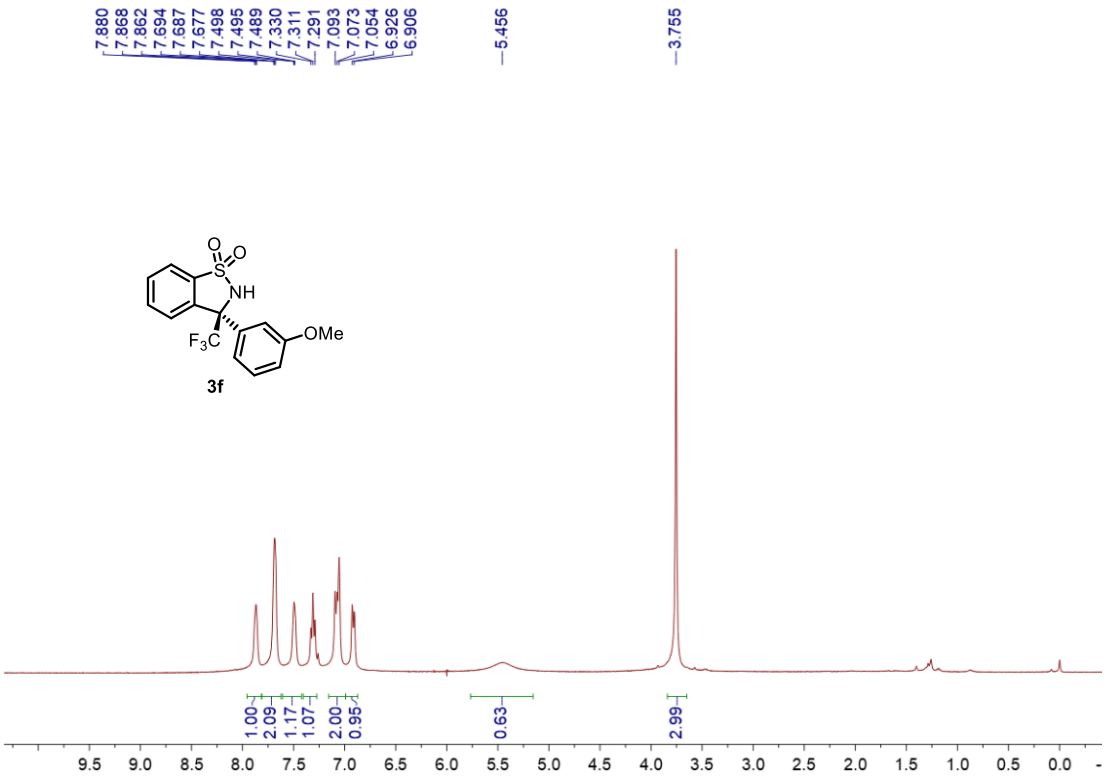
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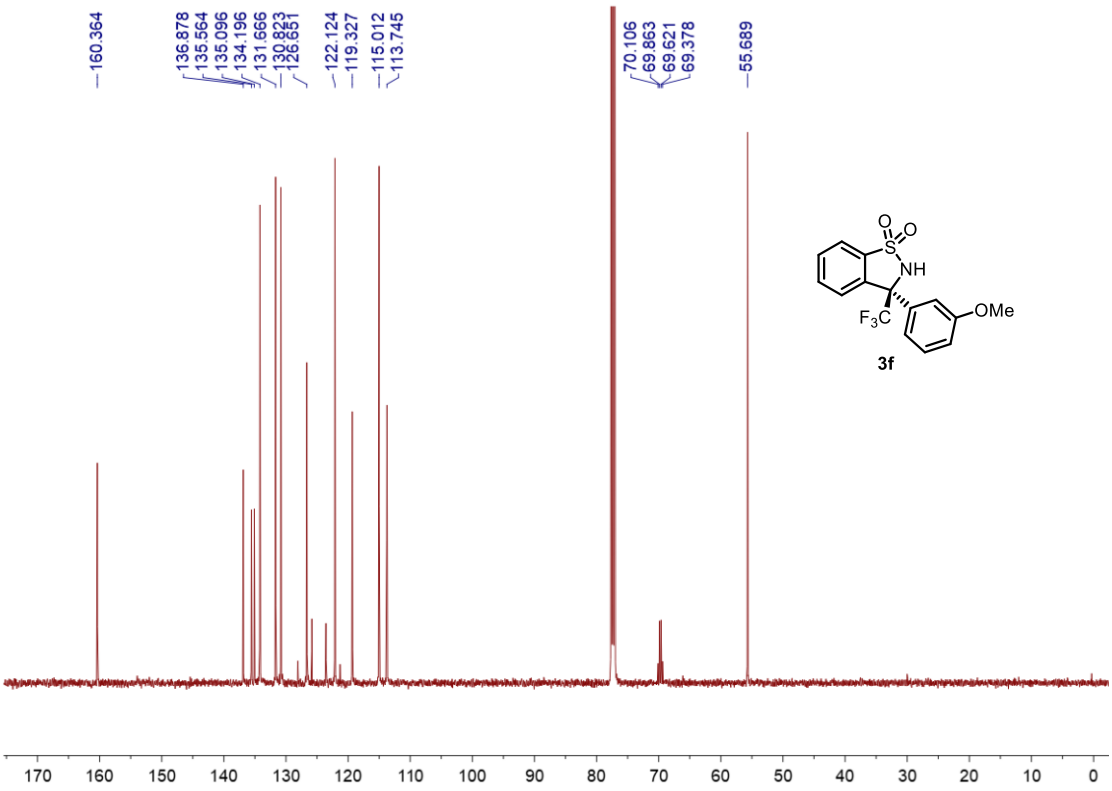
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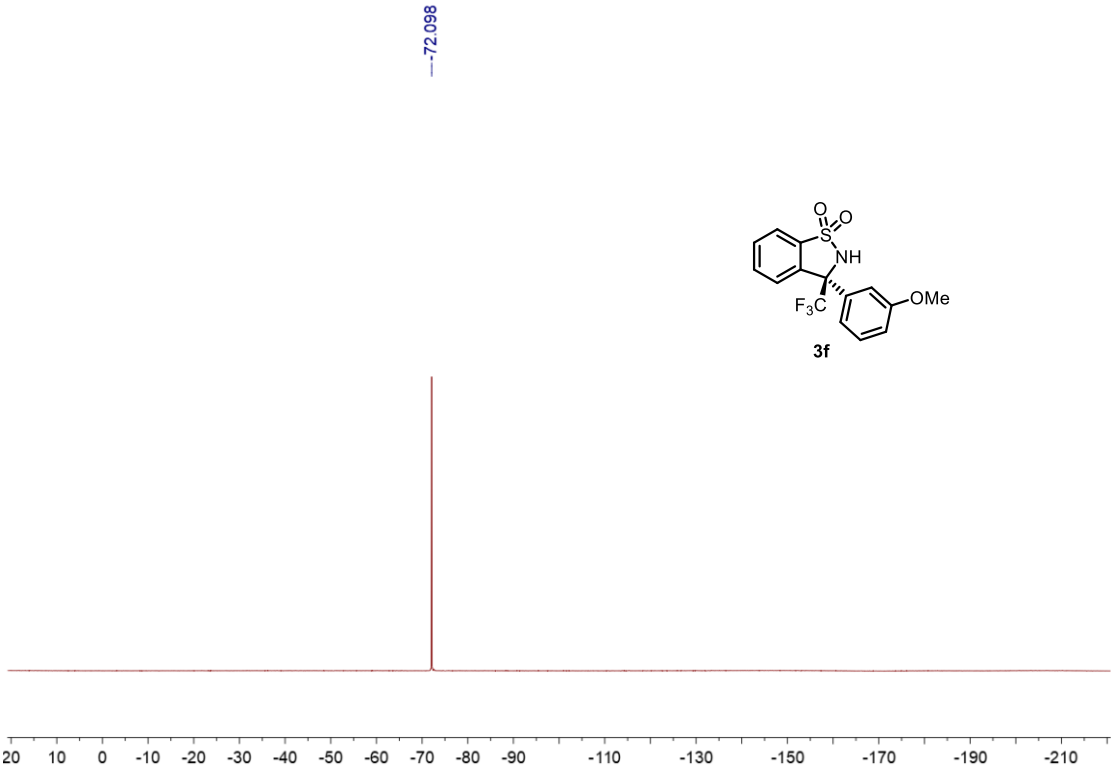
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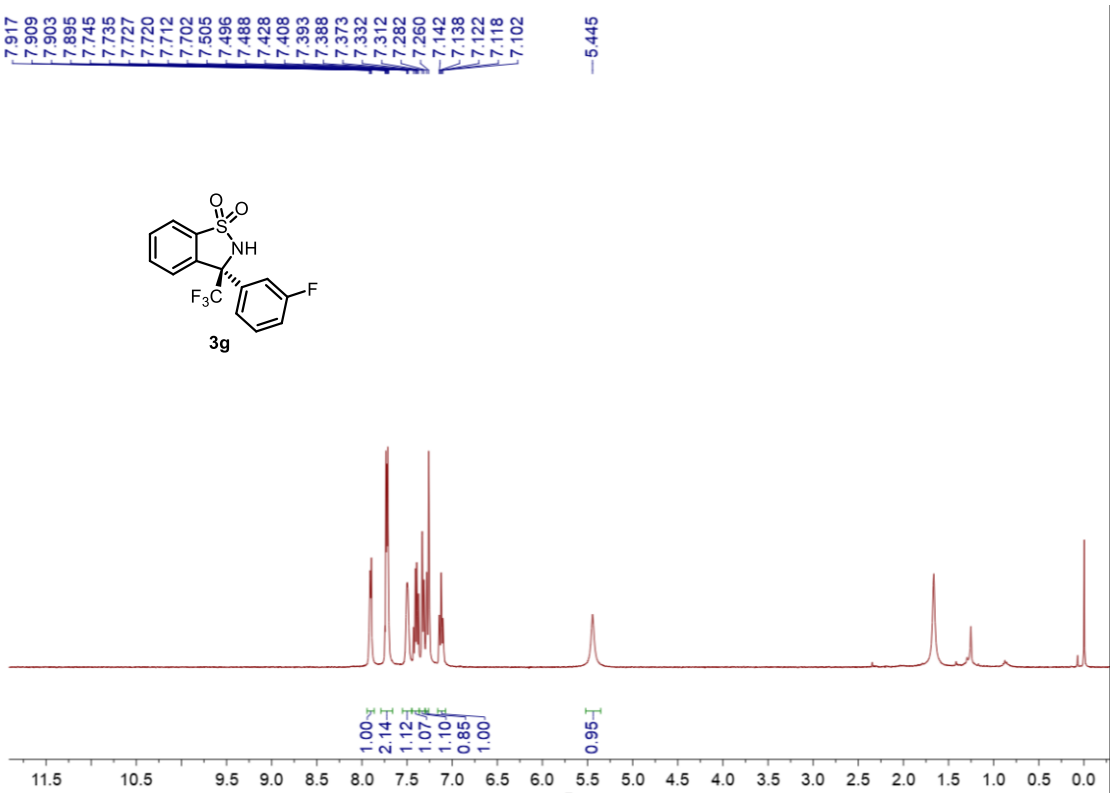
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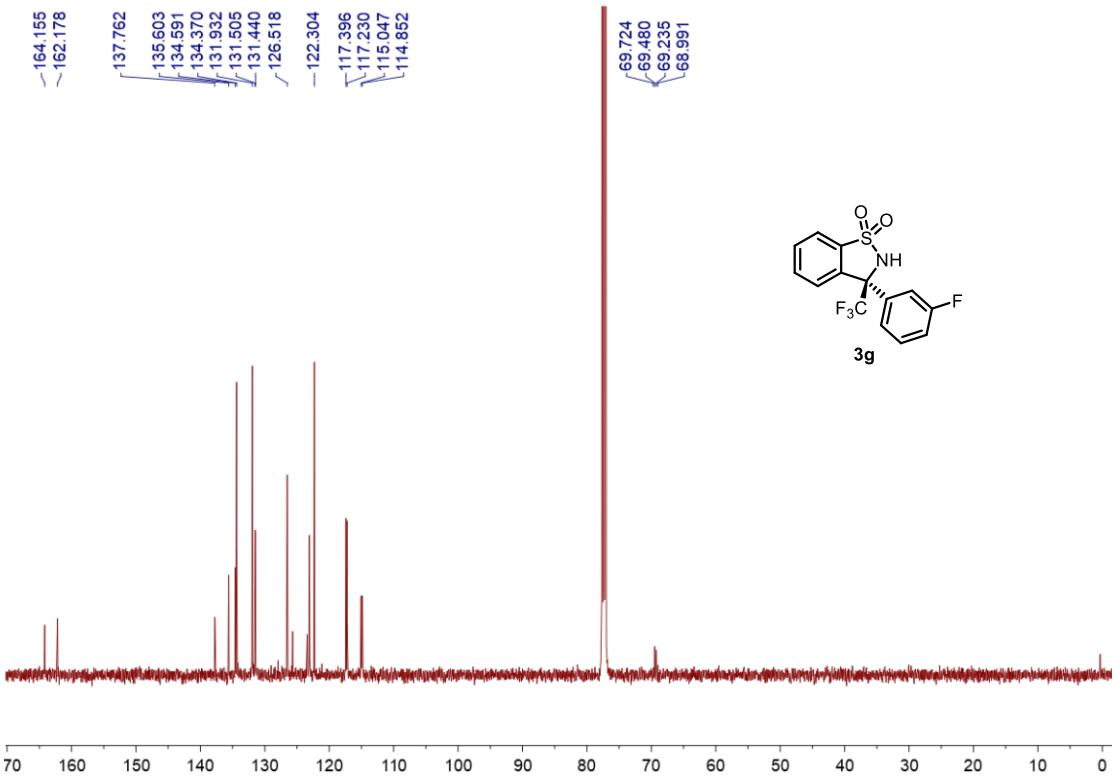
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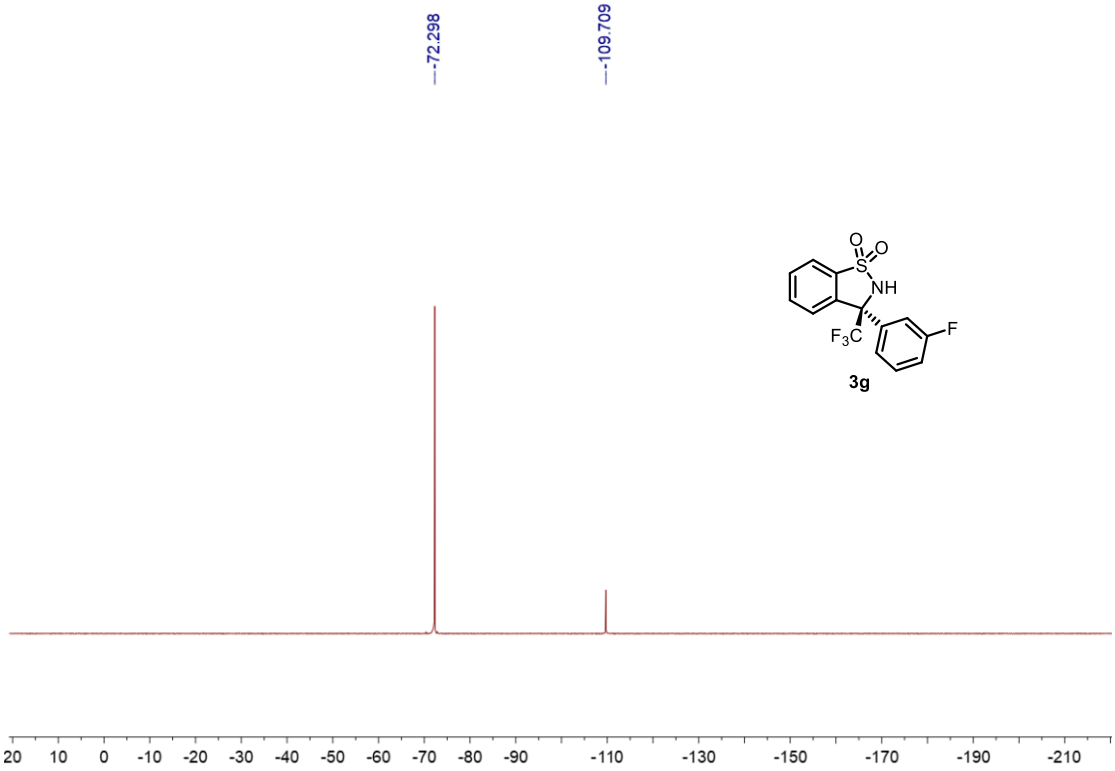
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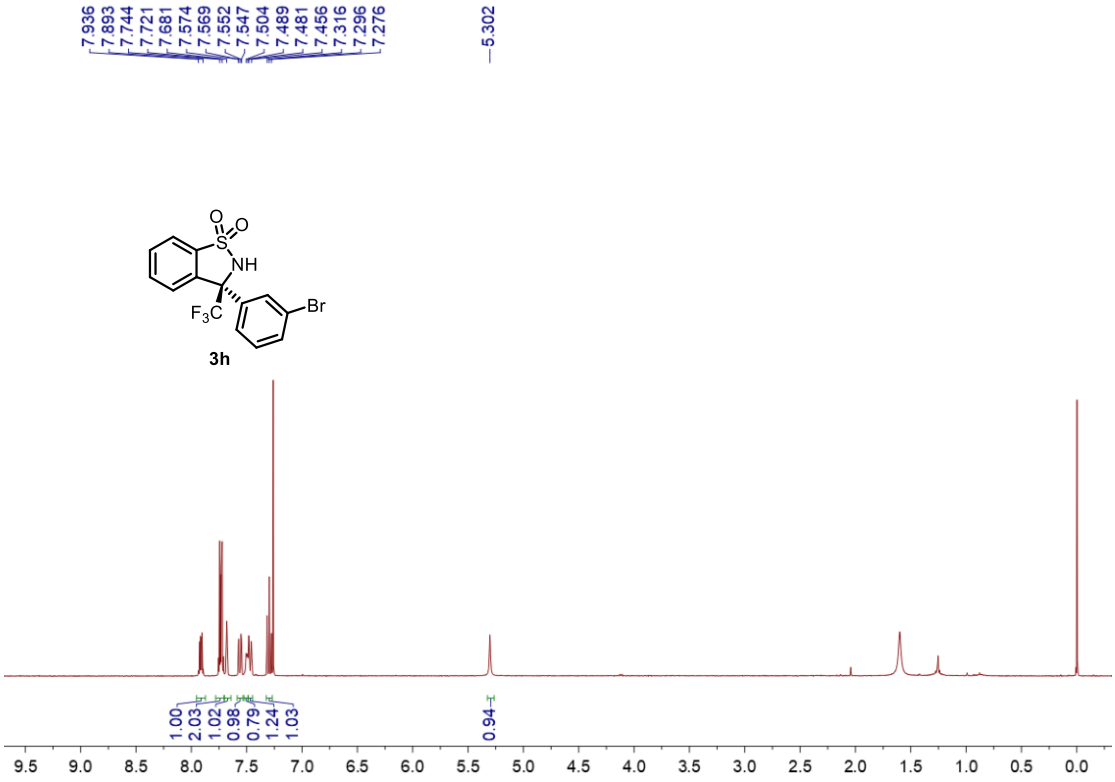
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7.547
7.504
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7.481
7.456
7.316
7.296
7.276
5.302
O
O
S
NH
F3C
Br
3h
1.00
2.03
1.02
0.98
0.79
1.24
1.03
0.94
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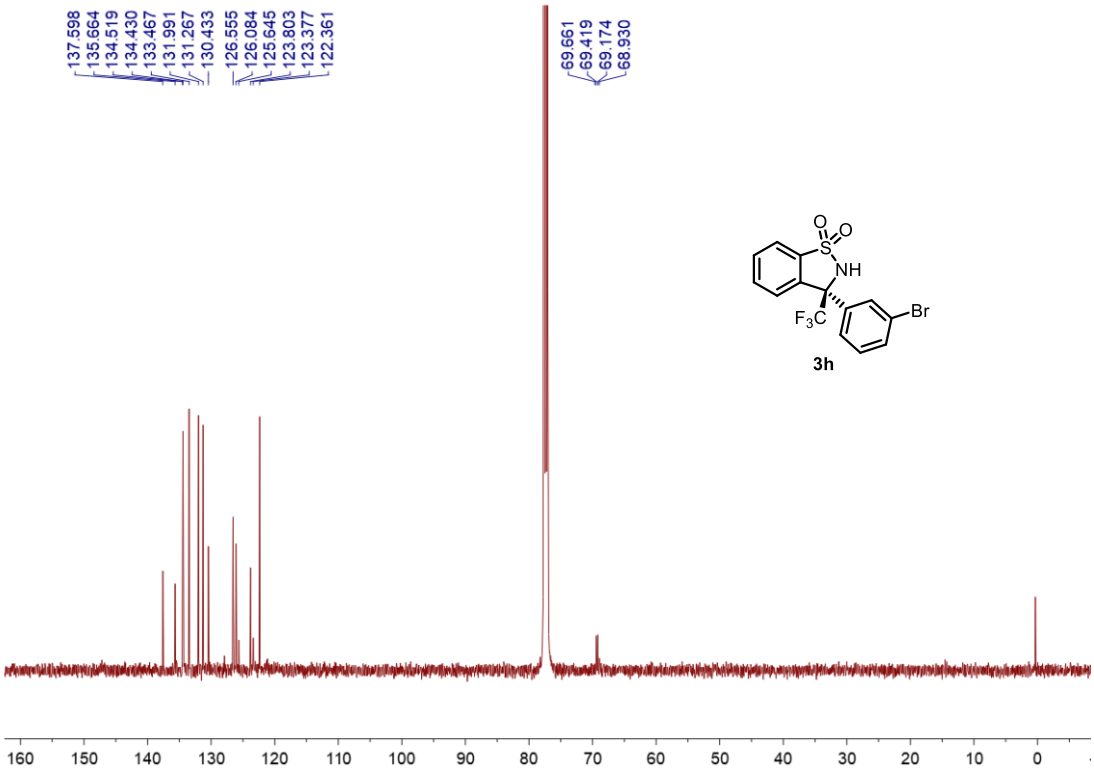
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126.084
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123.377
122.361
69.661
69.419
69.174
68.930
O
O
S
NH
F3C
Br
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10
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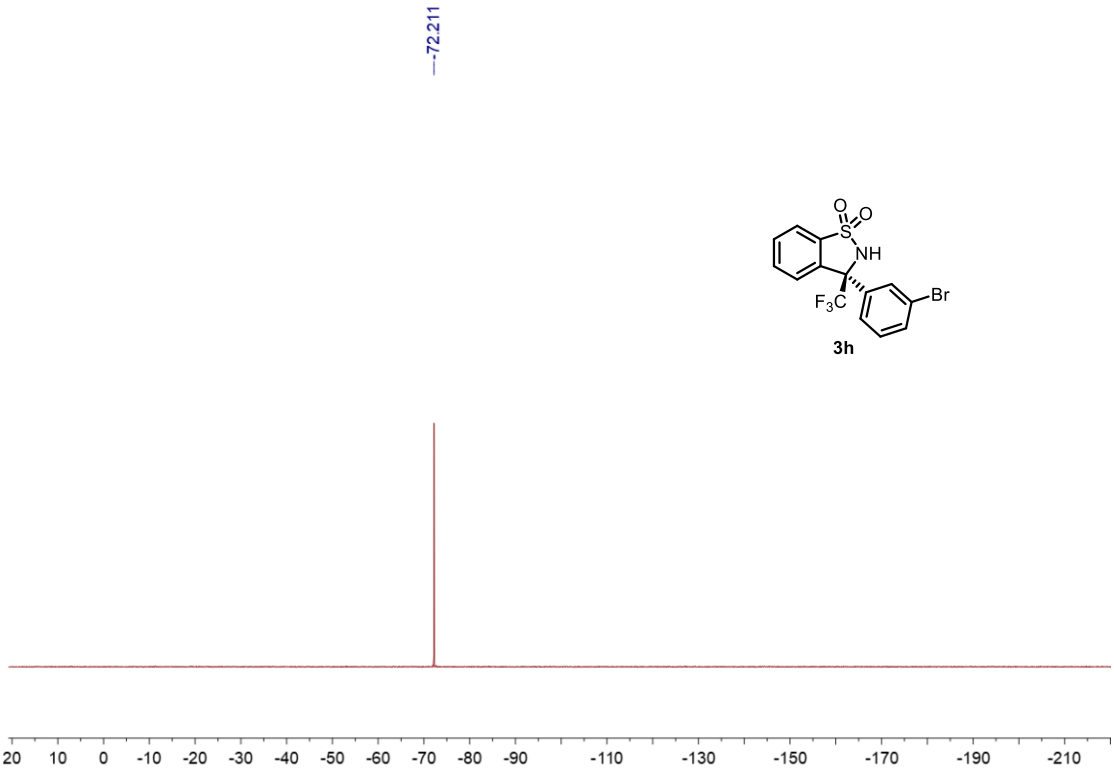
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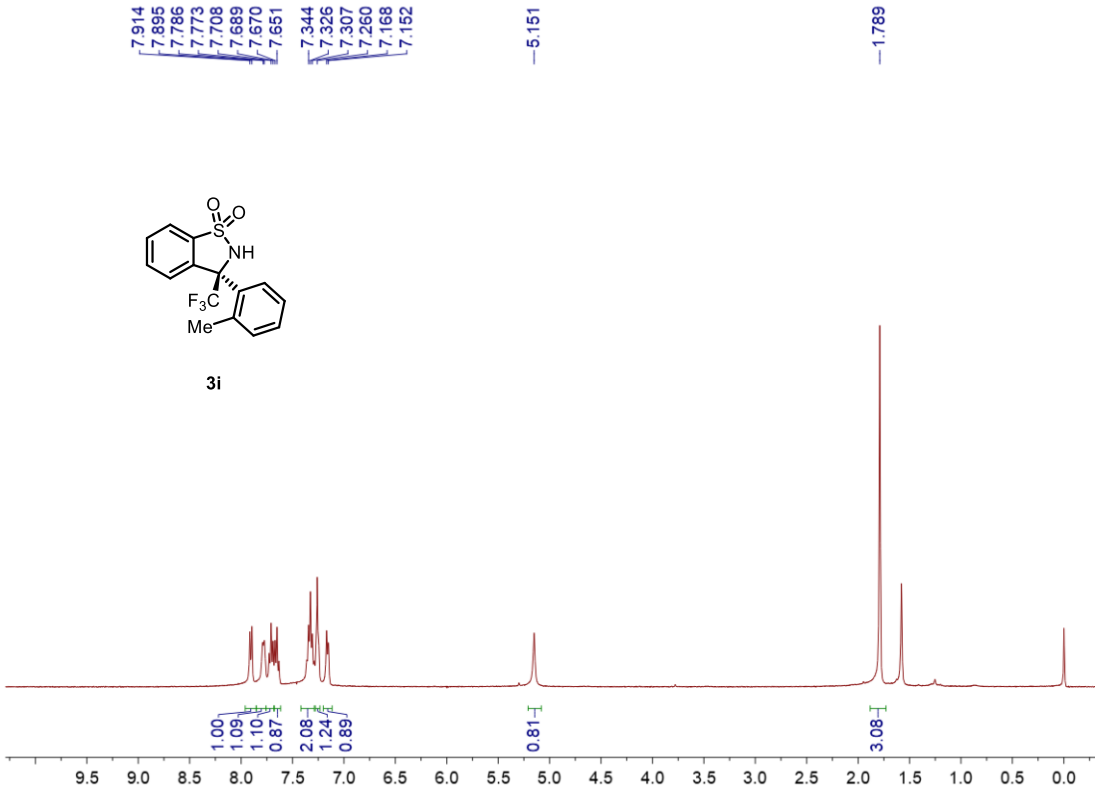
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7.152
5.151
1.789
O
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NH
F3C
Me
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1.09
1.10
0.87
2.08
1.24
0.89
0.81
3.08
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
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1.5
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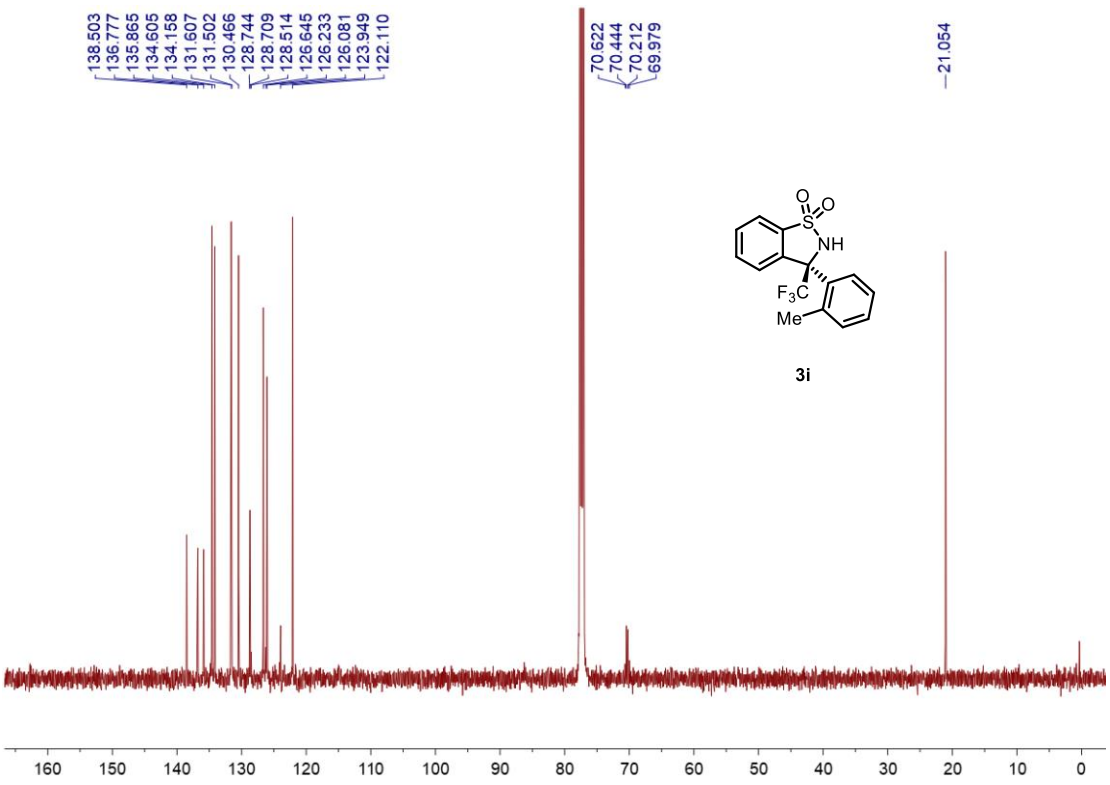
0.0

3i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130.466
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128.709
128.514
126.645
126.233
126.081
123.949
122.110
70.622
70.444
70.212
69.979
21.054
O
O
S
NH
F3C
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60
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20
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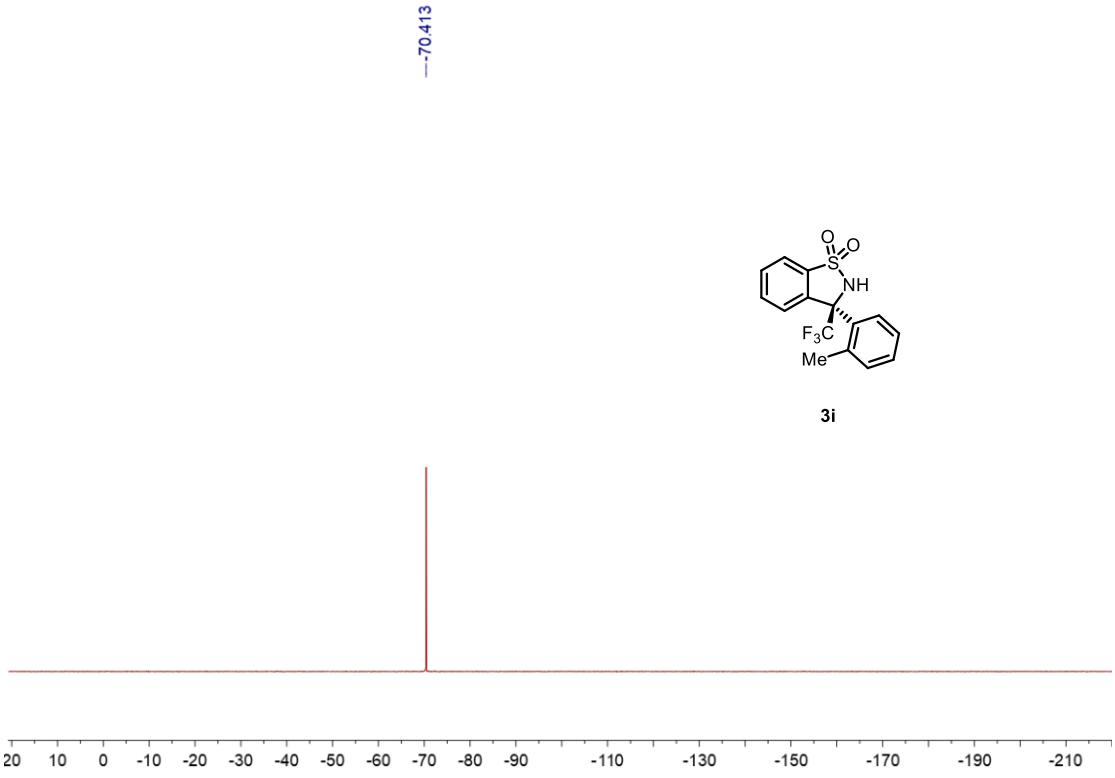
0

3i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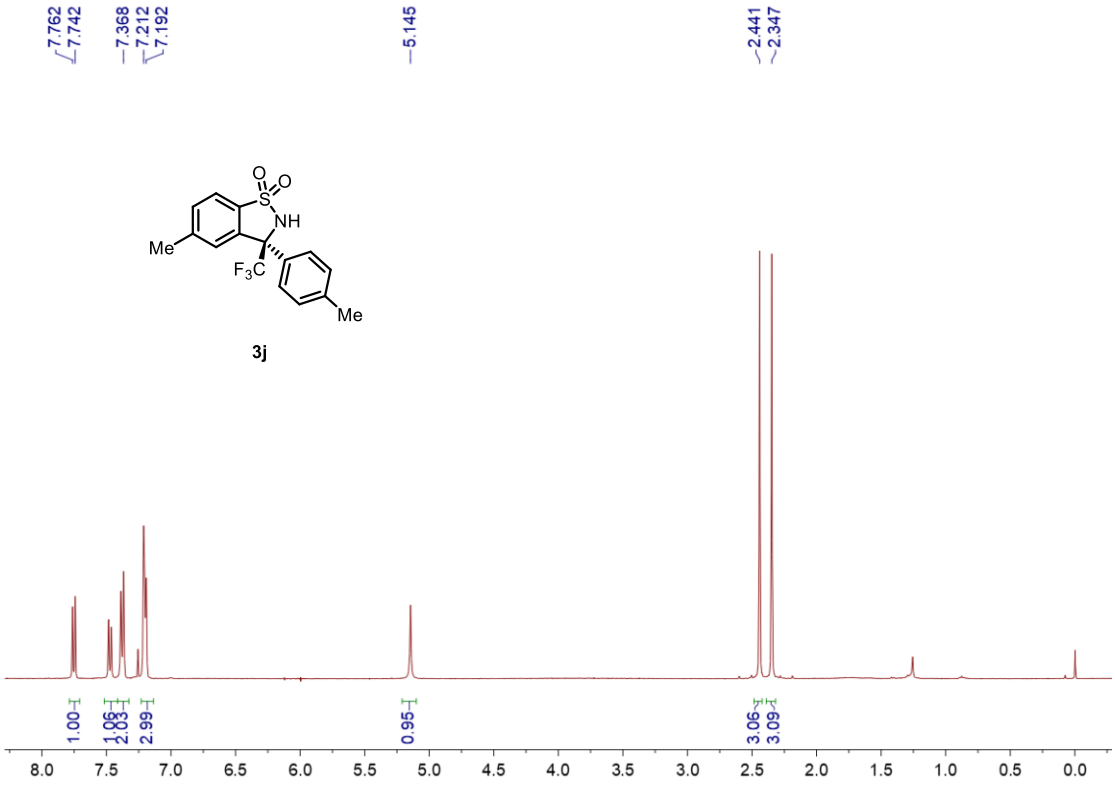
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7.368
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7.192
5.145
2.441
2.347
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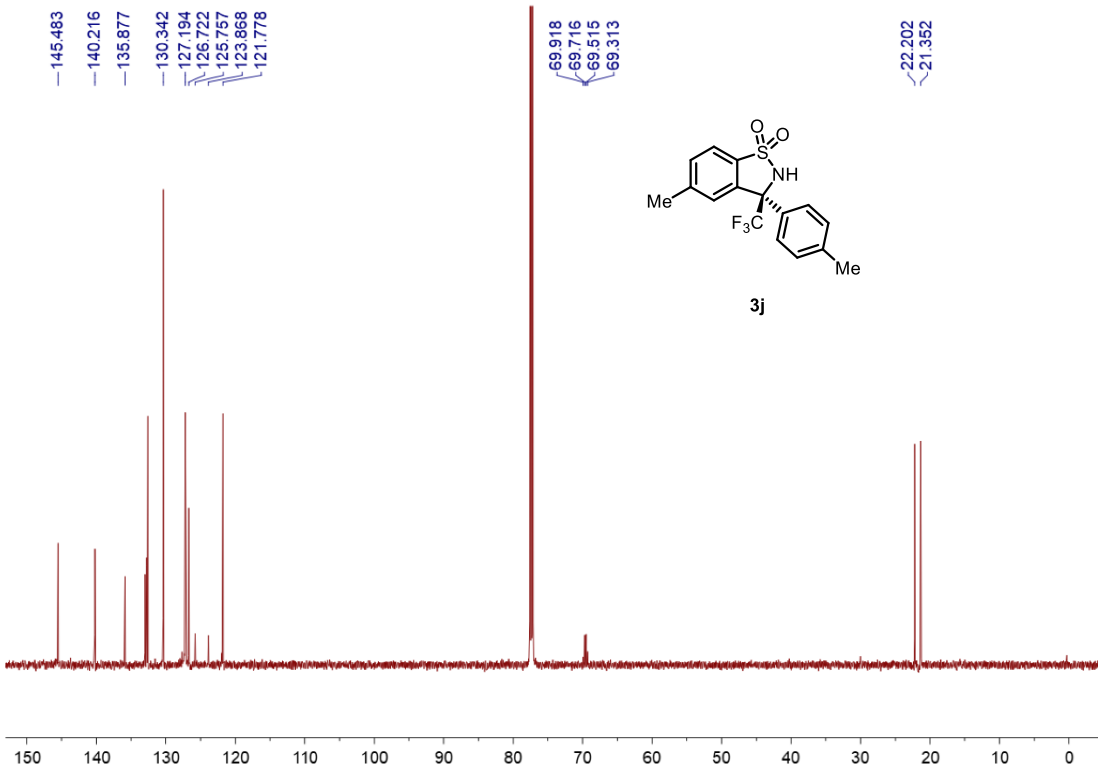
O
S
NH
Me
F3C
Me
1.00
1.06
2.03
2.99
0.95
3.06
3.09
8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0

3j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125.757
123.868
121.778
69.918
69.716
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69.313
22.202
21.352
O
O
S
NH
Me
F3C
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100
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20
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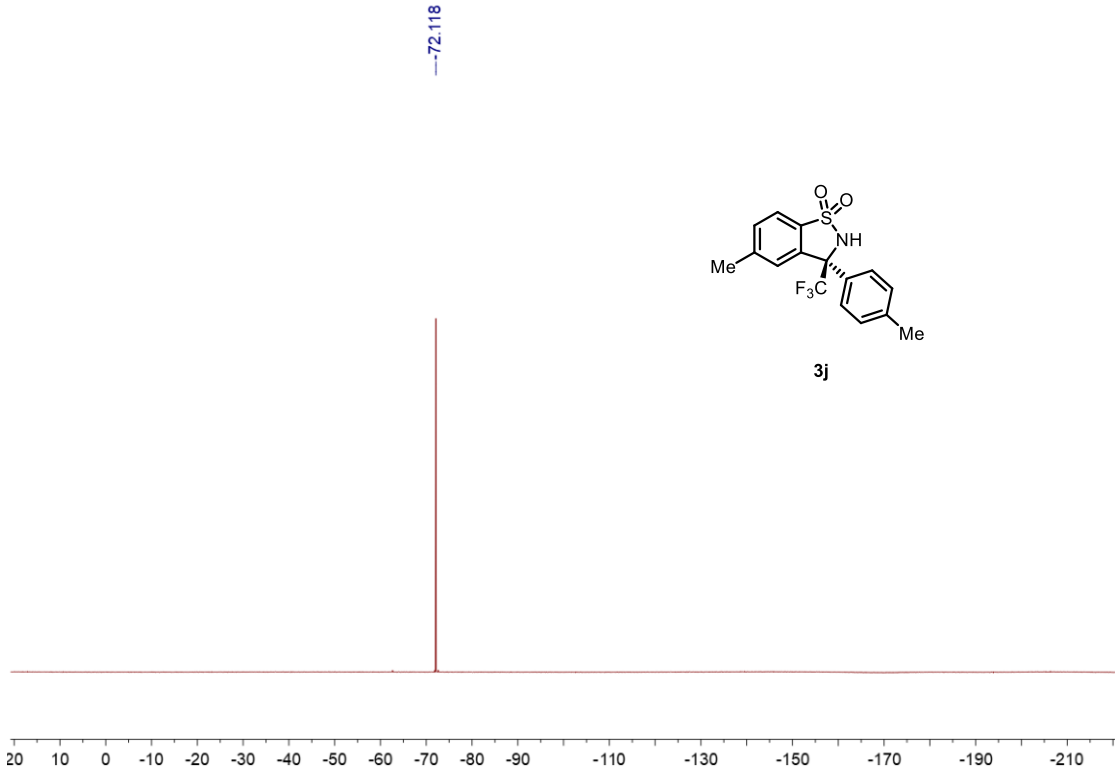
0

3j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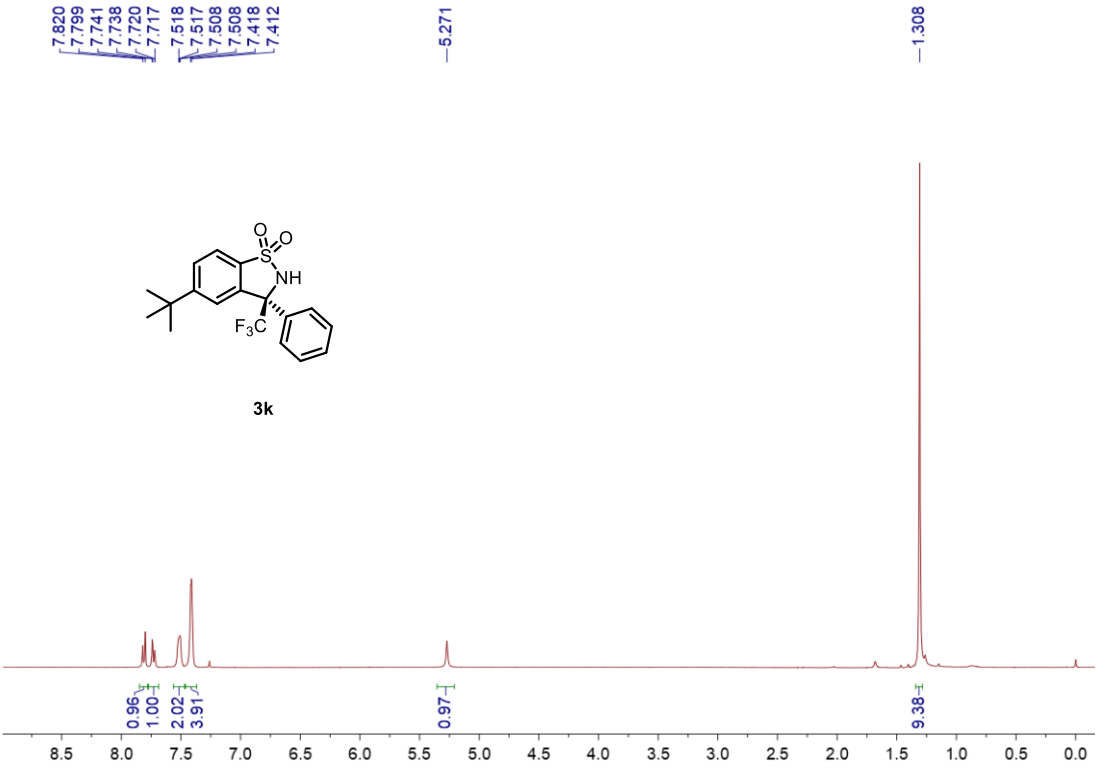
-190
-210

3j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7.508
7.508
7.418
7.412
5.271
1.308
O
O
S
NH
F3C
0.96
1.00
2.02
3.91
0.97
9.38
8.5
8.0
7.5
7.0
6.5
6.0
5.5
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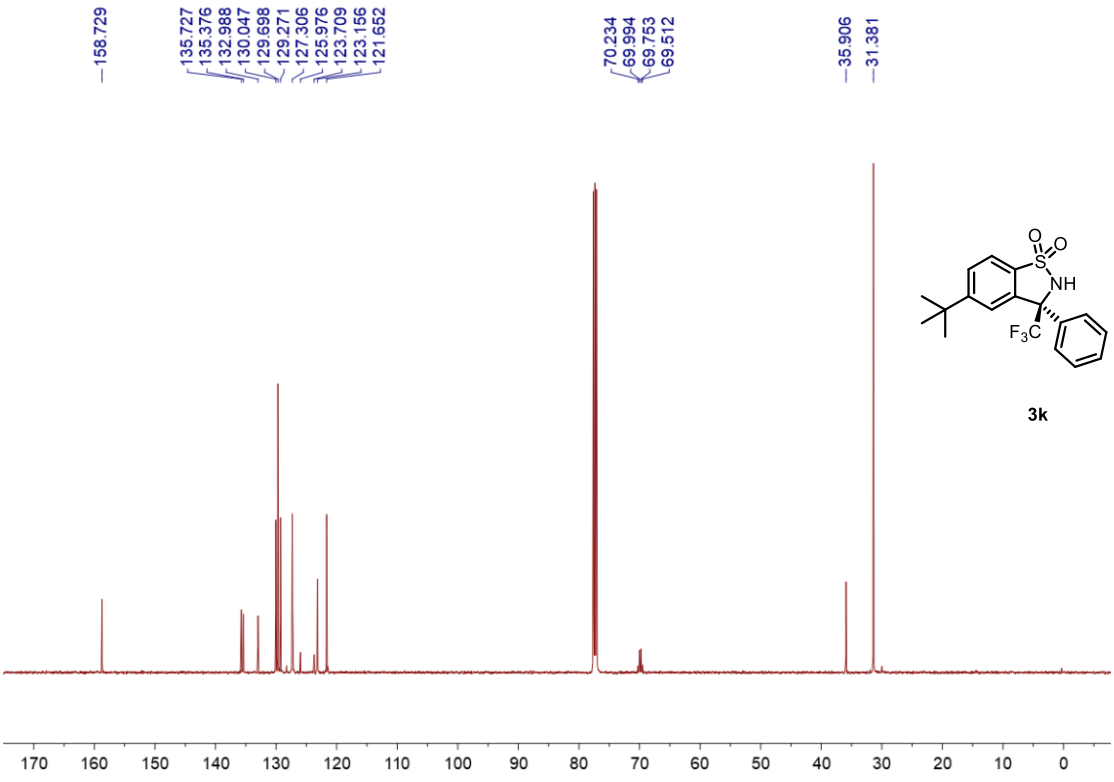
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

3k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129.271
127.306
125.976
123.709
123.156
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70.234
69.994
69.753
69.512
35.906
31.381
O
O
S
NH
F3C
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160
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140
130
120
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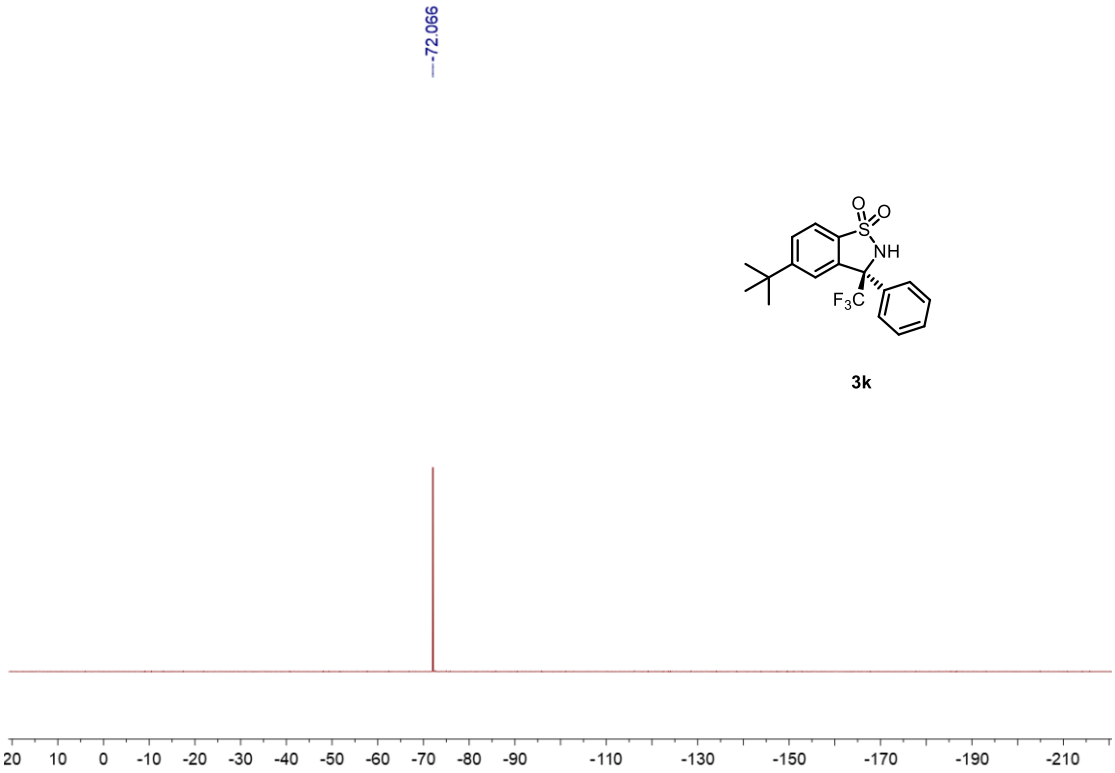
100
90
80
70
60
50
40
30
20
10
0

3k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NH
F3C
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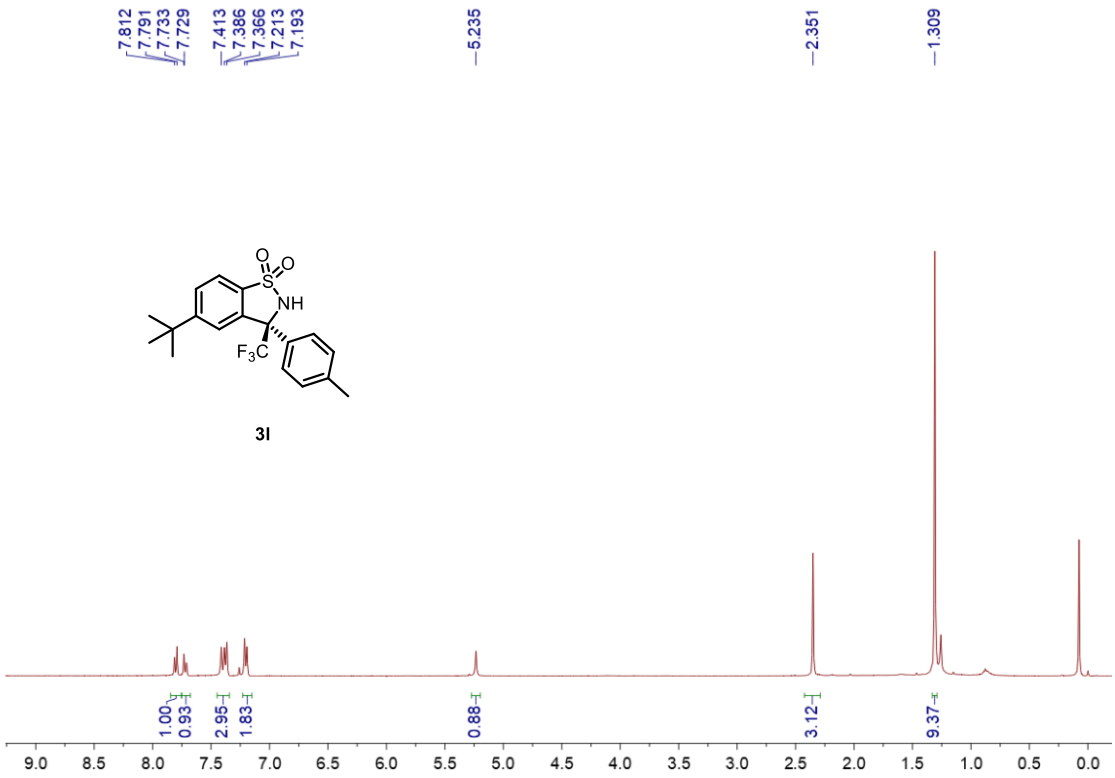
3k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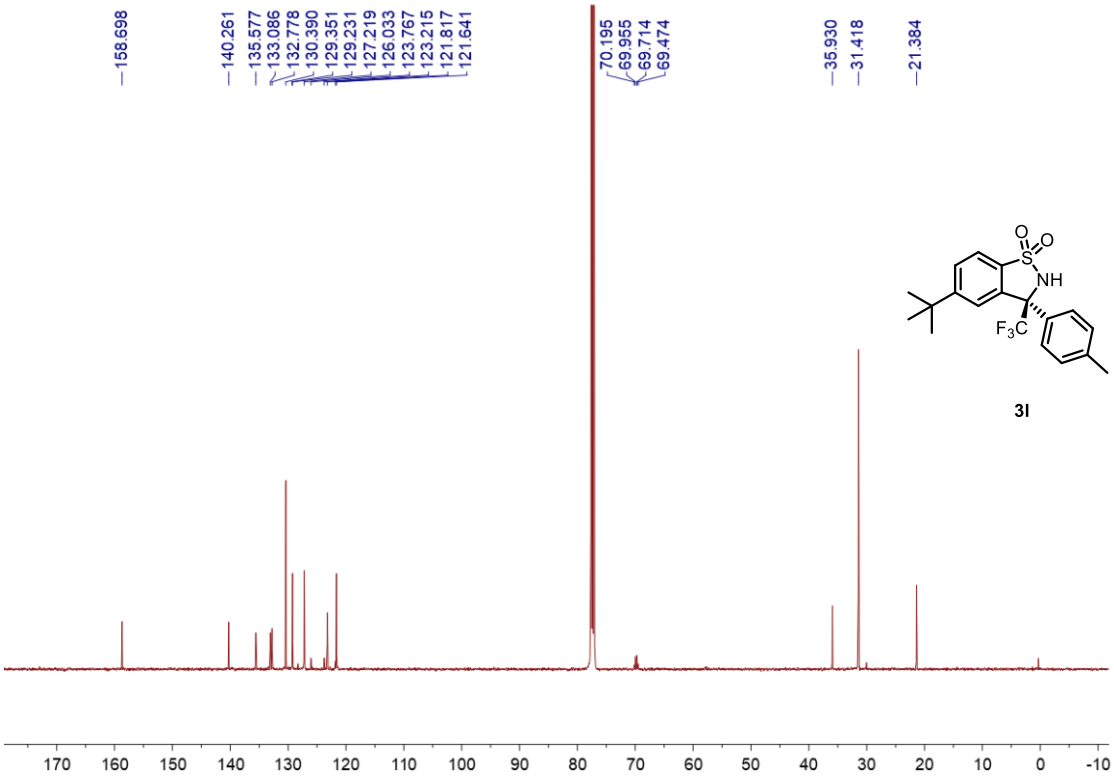
7.366
7.213
7.193
5.235
2.351
1.309
NH
F3C
1.00
0.93
2.95
1.83
0.88
3.12
9.37
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0

3l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126.033
123.767
123.215
121.817
121.641
70.195
69.955
69.714
69.474
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21.384
O
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S
NH
F3C
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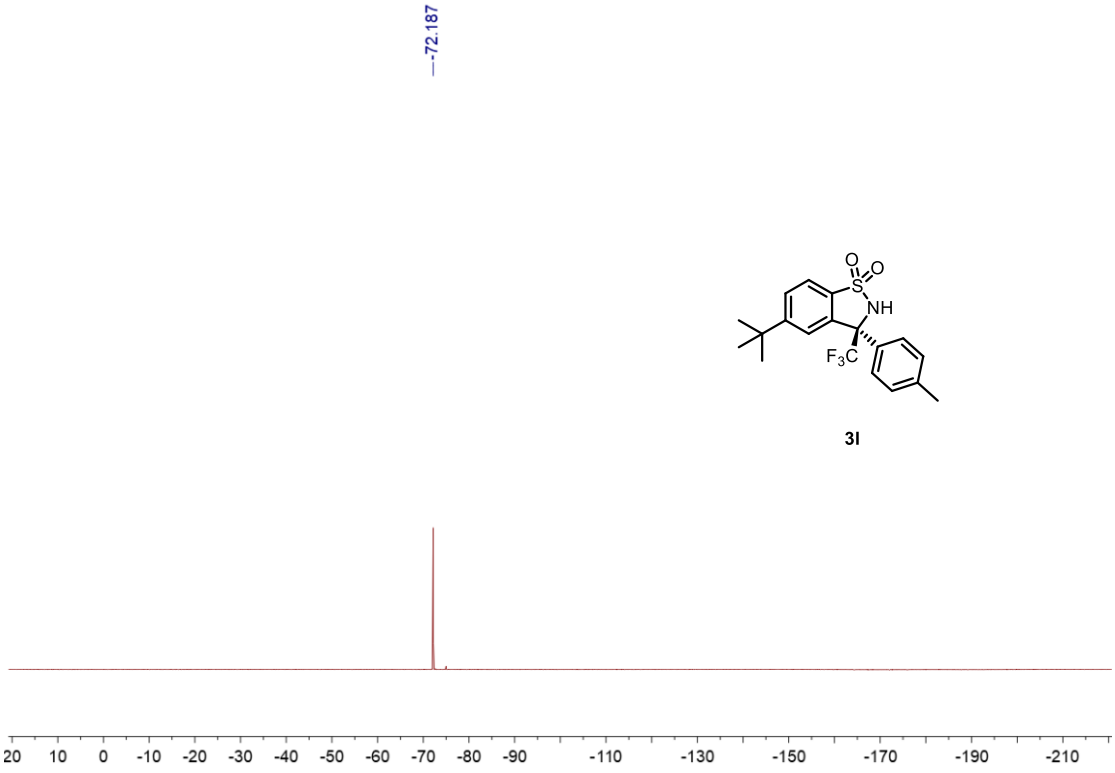
3l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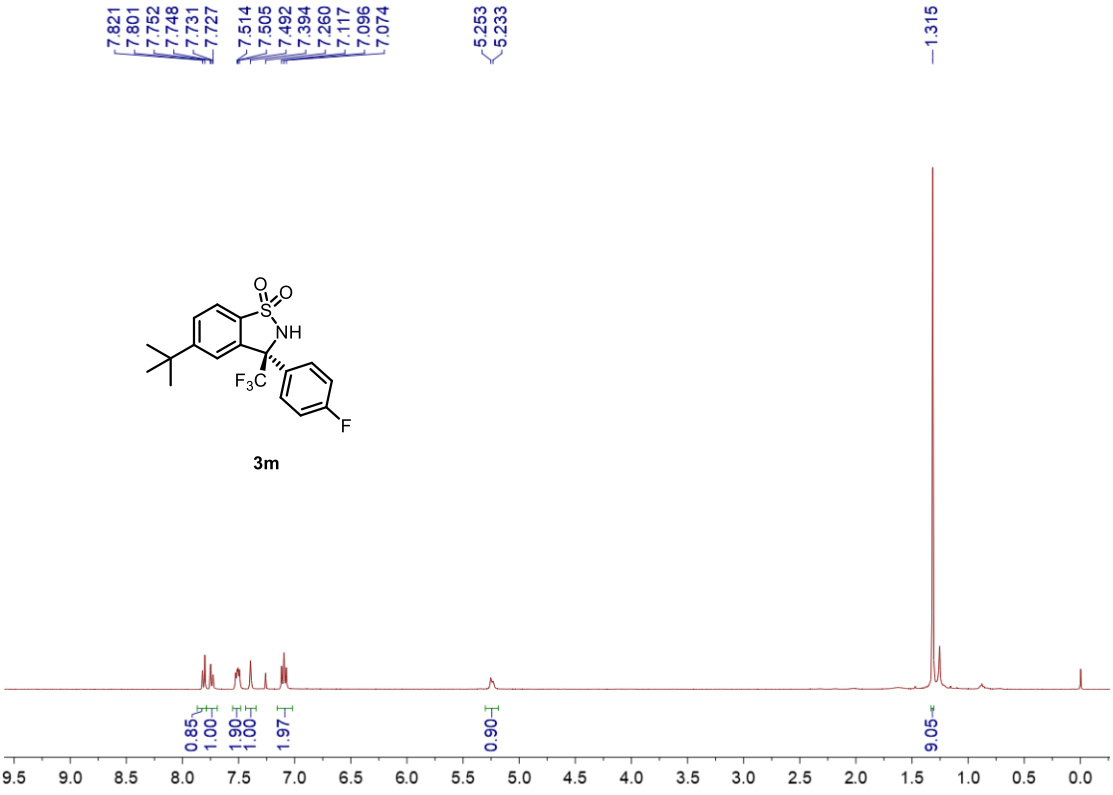
3l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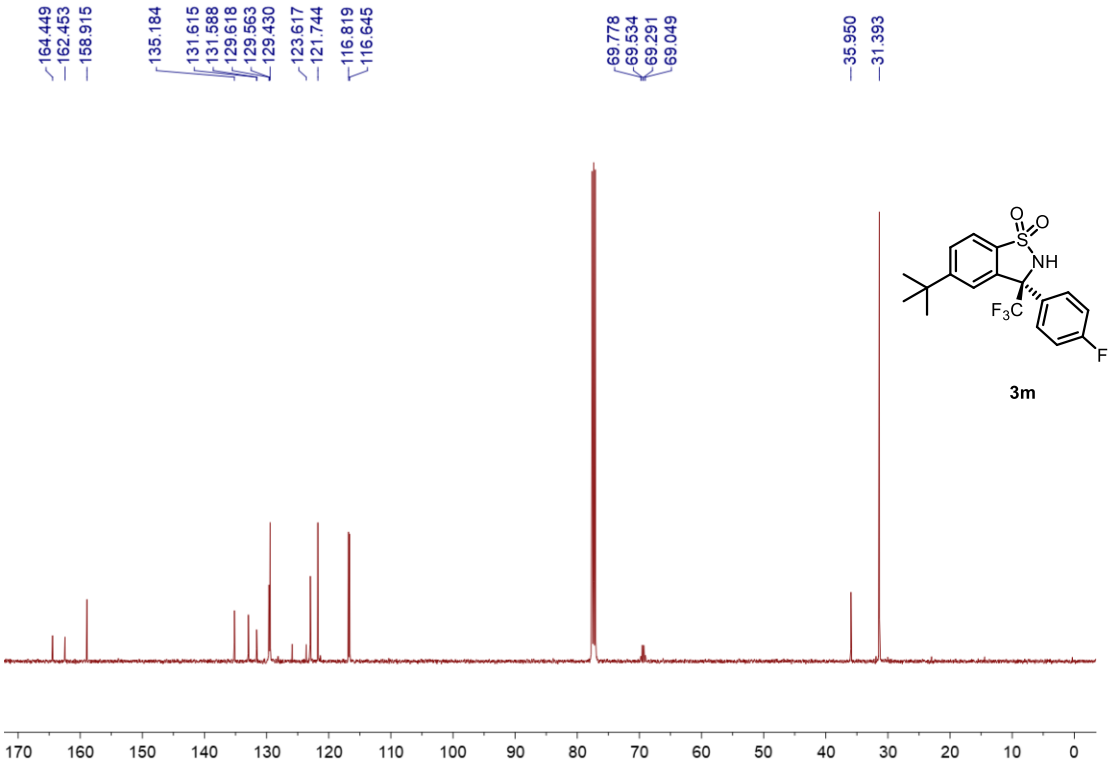
7.514
7.505
7.492
7.394
7.260
7.117
7.096
7.074
5.253
5.233
1.315
O
O
S
NH
F3C
F
0.85
1.00
1.90
1.00
1.97
0.90
9.05
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0

3m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116.819
116.645
69.778
69.534
69.291
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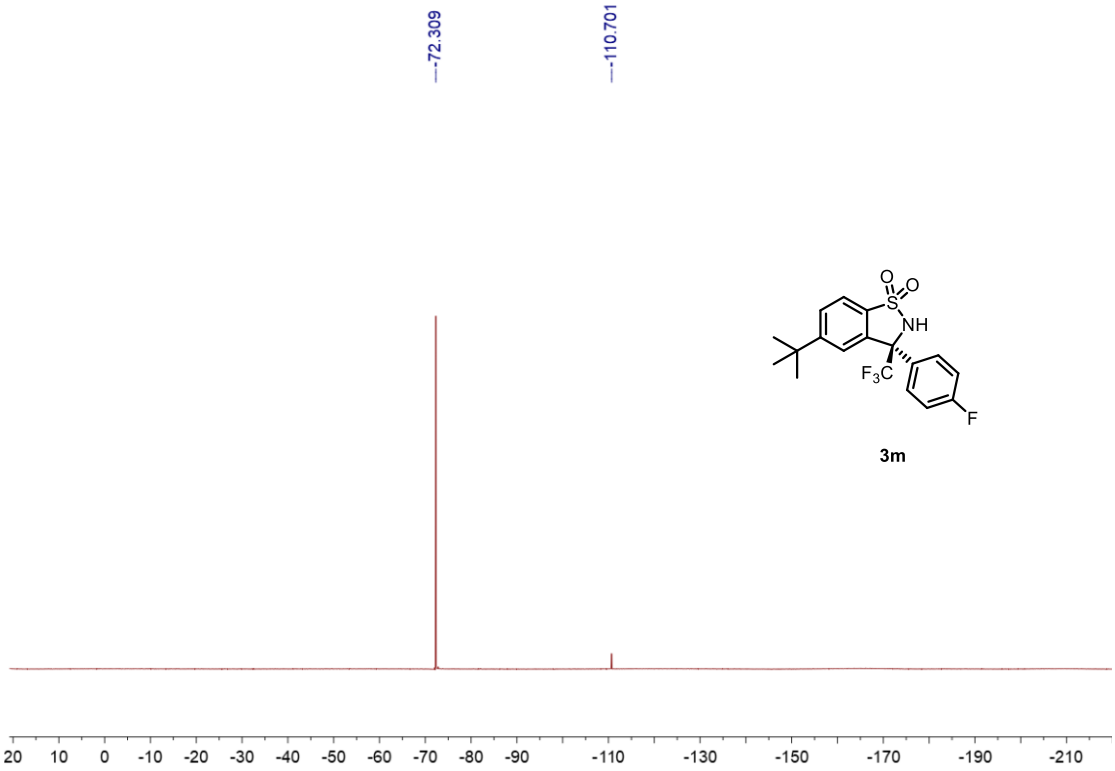
F3C
F
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0

3m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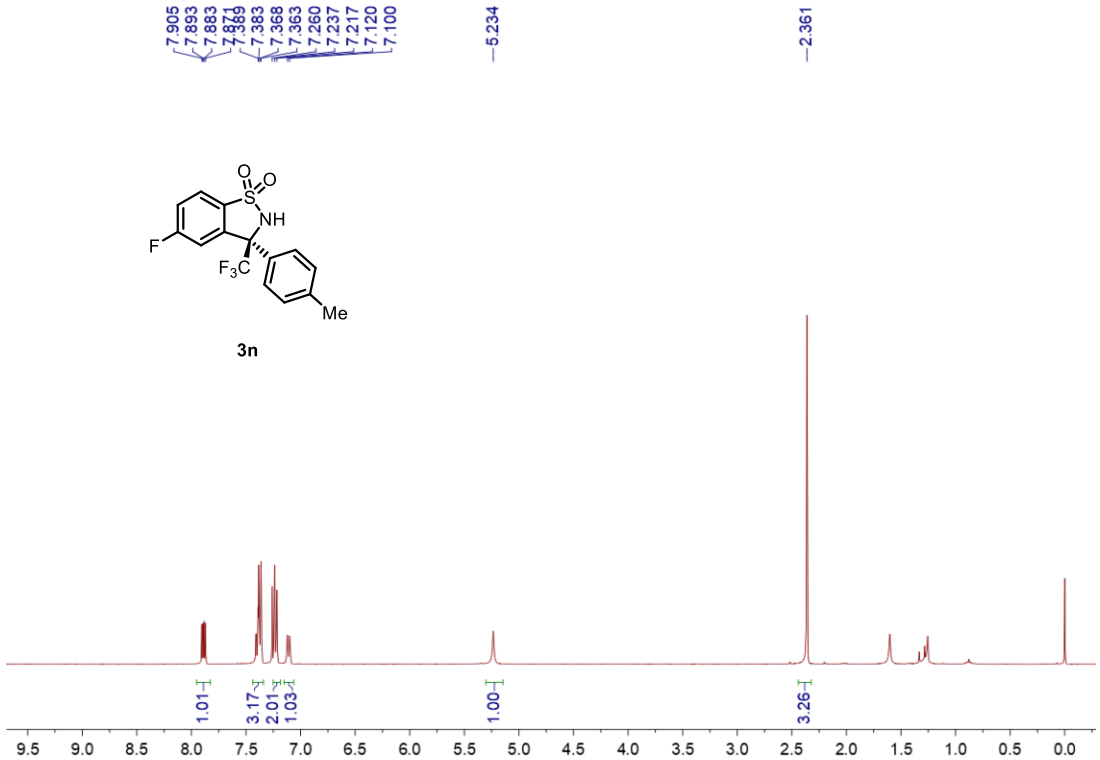
3m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5.234
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O
O
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NH
F
F3C
Me
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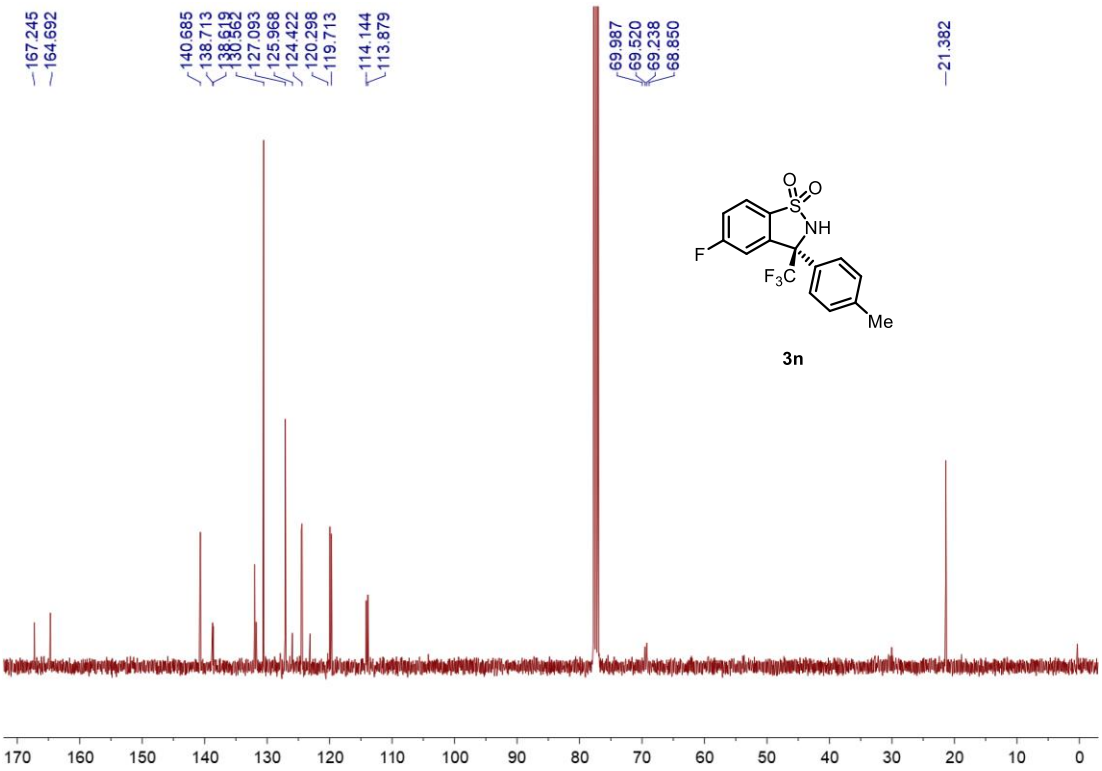
3.17
2.01
1.03
1.00
3.26
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0

3n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69.520
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F3C
Me
3n
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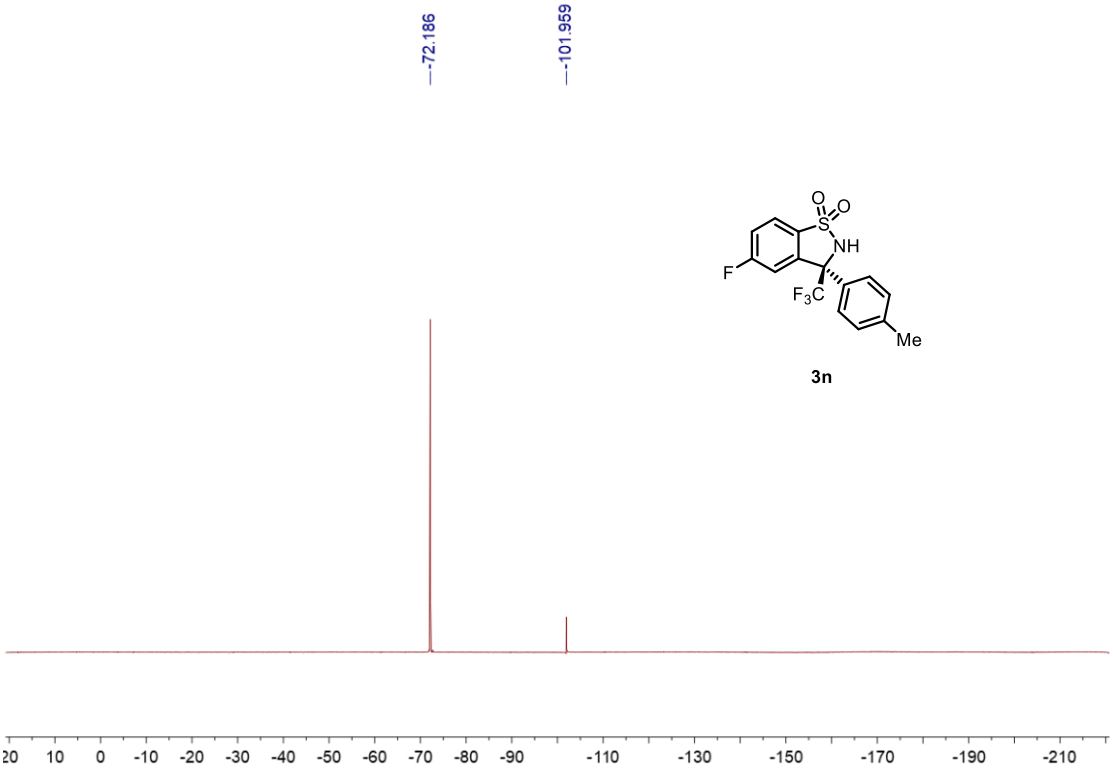
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8.060
8.040
8.030
8.010
7.988
7.967
7.890
7.870
7.716
7.697
7.596
7.577
7.561
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7.490
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7.312
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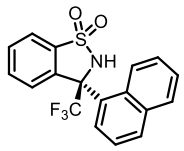
7.217
5.436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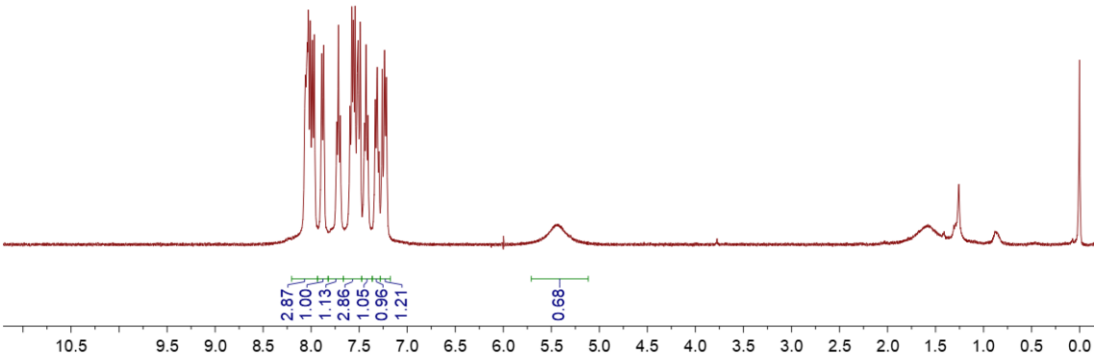
F3C

3o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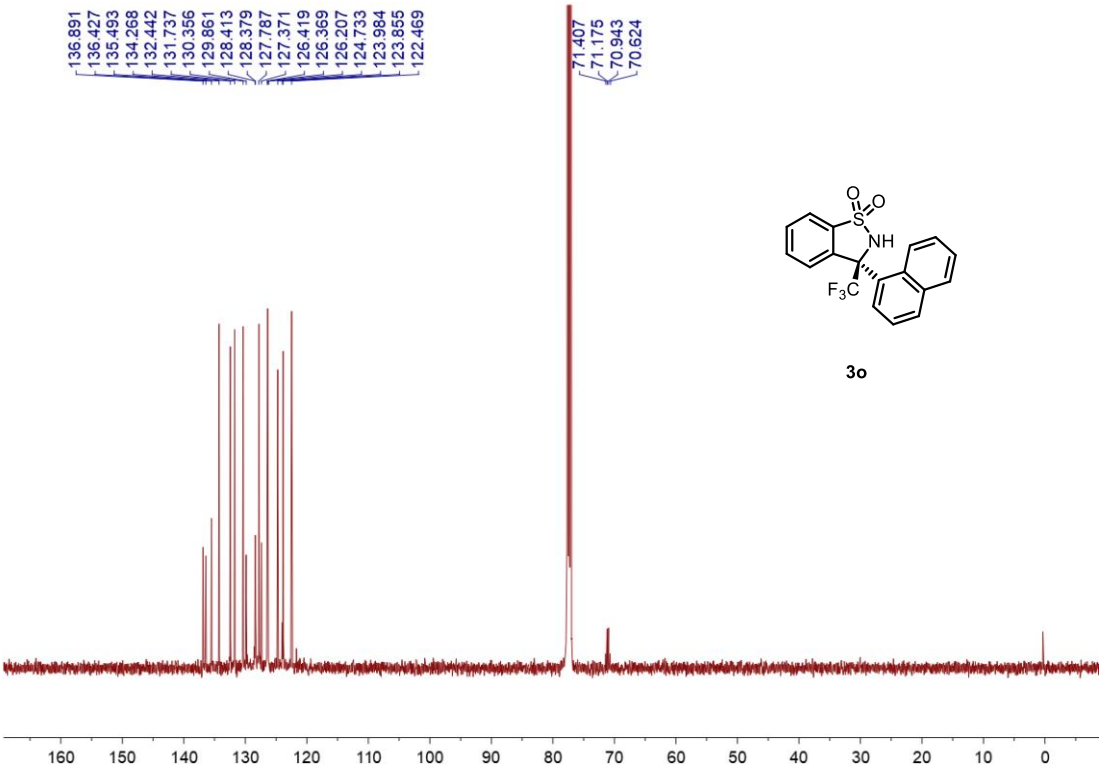
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20
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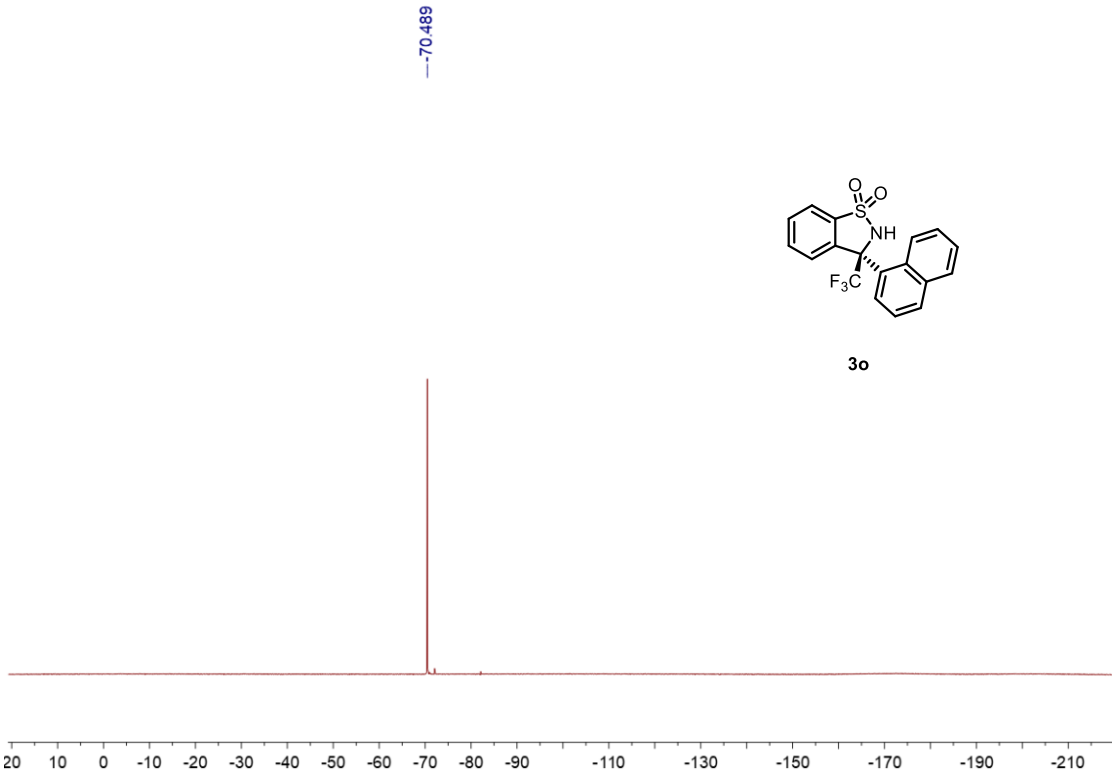
0

O
O
S
NH
F3C

3o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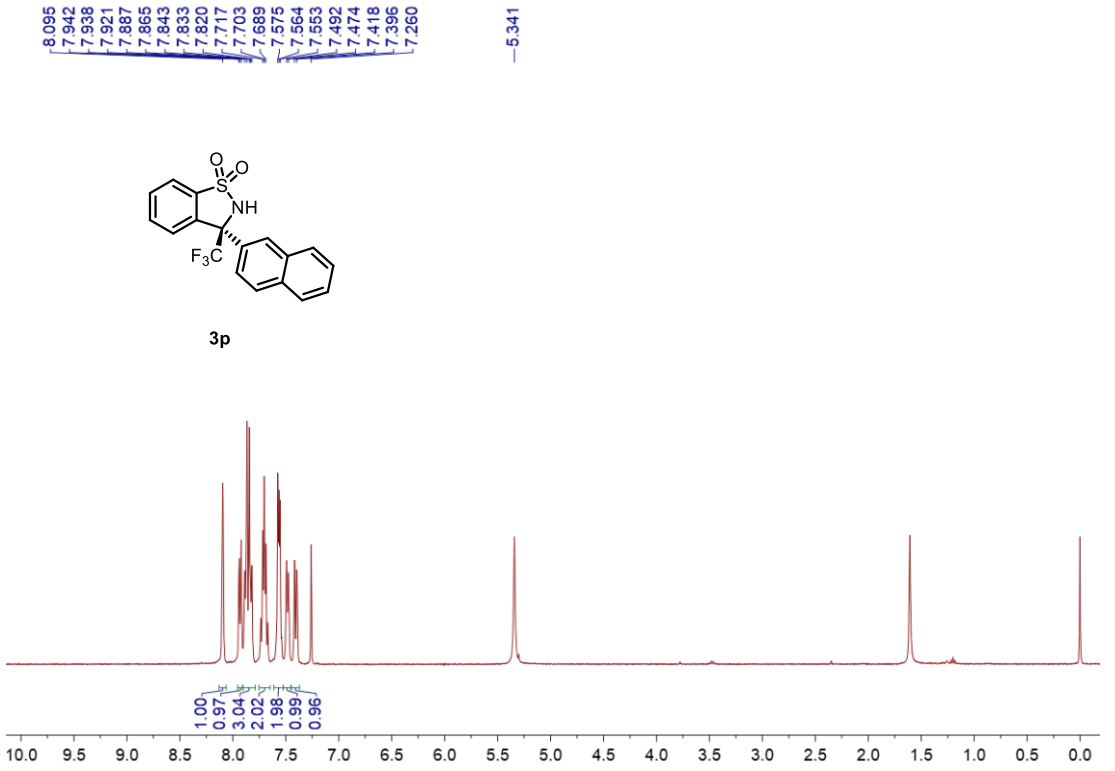
3o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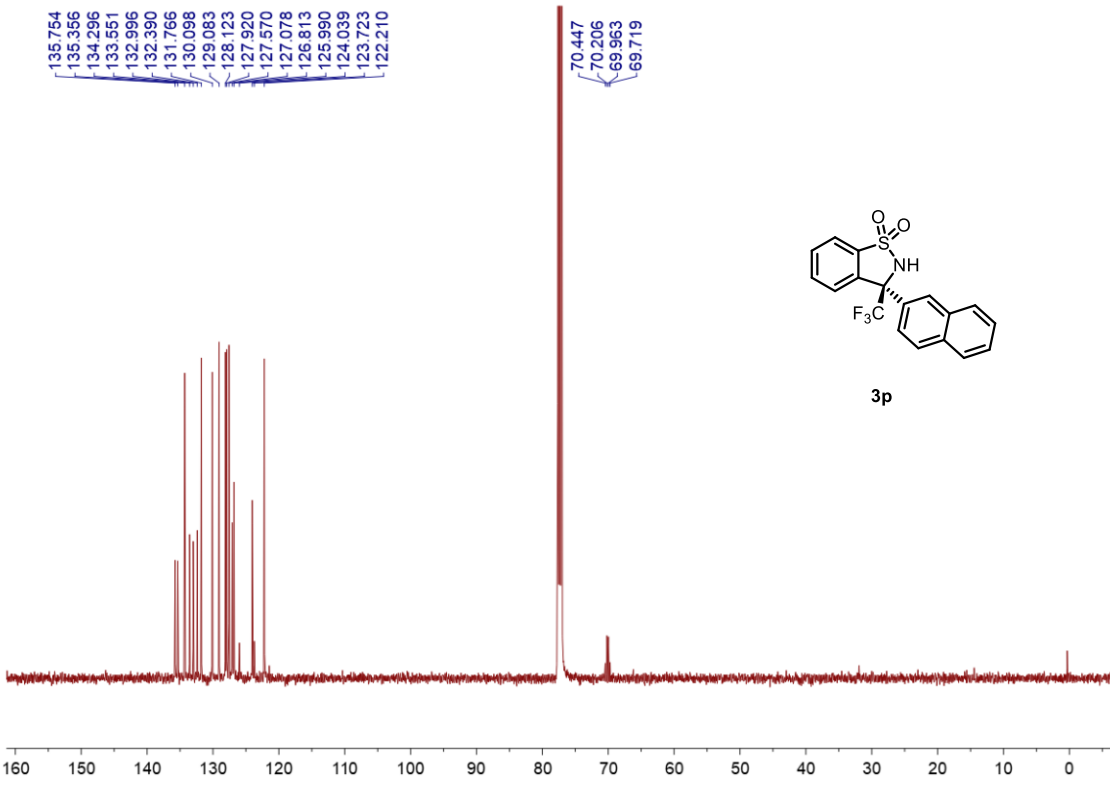
7.575
7.564
7.553
7.492
7.474
7.418
7.396
7.260
5.341
1.00
0.97
3.04
2.02
1.98
0.99
0.96
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0

3p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126.813
125.990
124.039
123.723
122.210
70.447
70.206
69.963
69.719
O
O
S
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F3C
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130
120
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100
90
80
70
60
50
40
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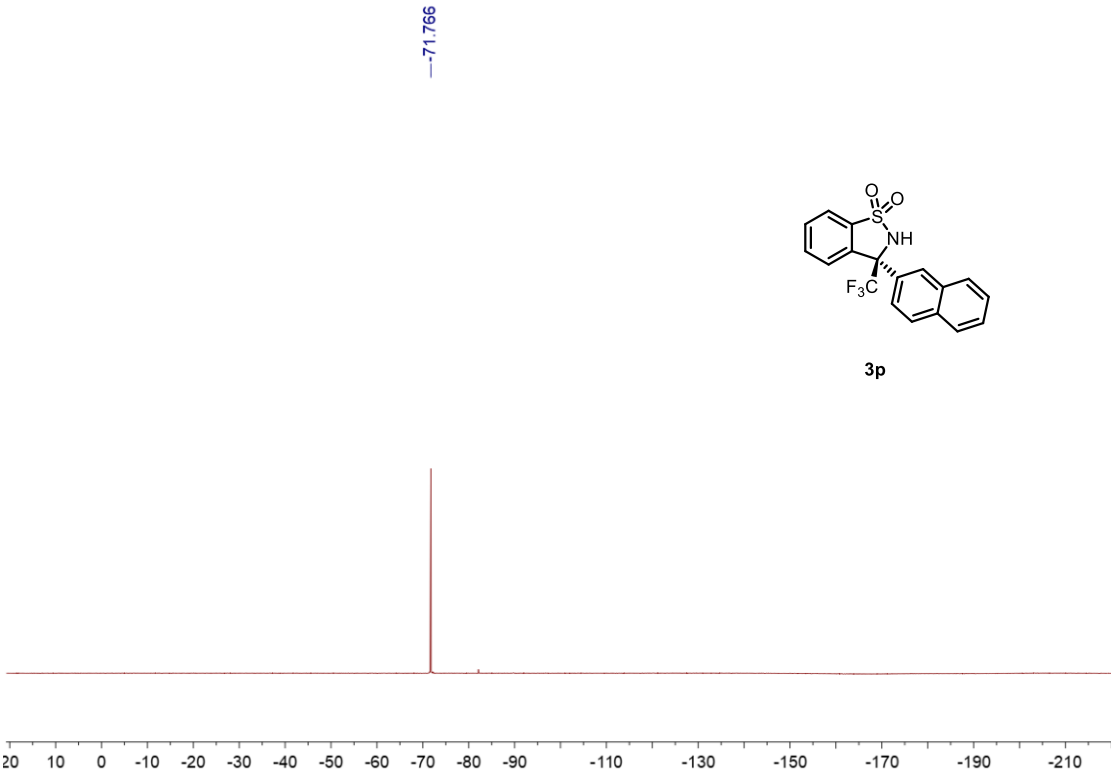
20
10
0

3p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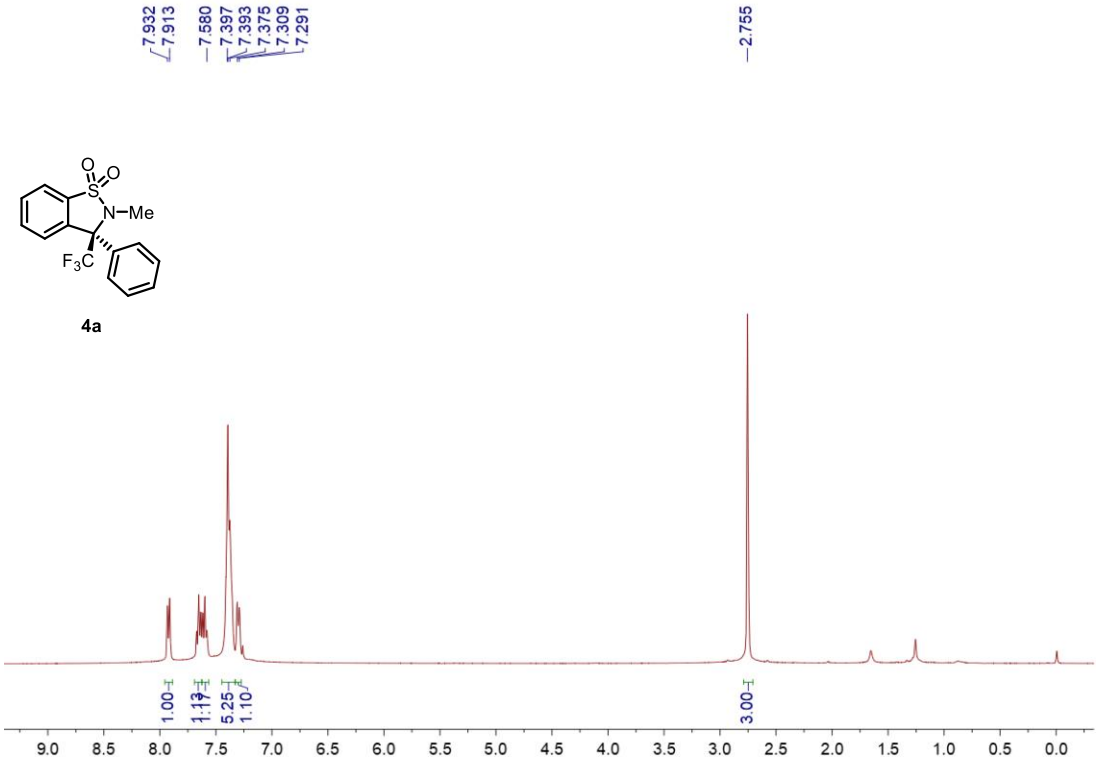
-130
-150
-170
-190
-210

3p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O
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F3C
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3.00
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
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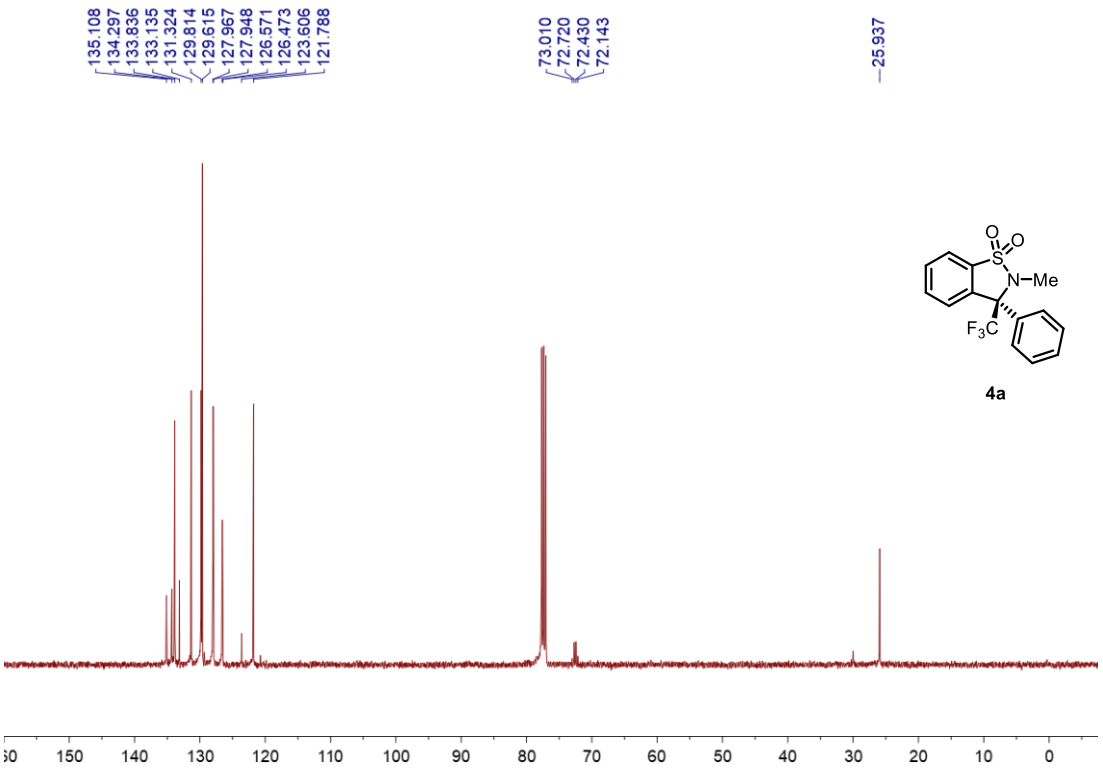
0.0

4a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73.010
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72.430
72.143
25.937
O
O
S
N–Me
F3C
150
140
130
120
110
100
90
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70
60
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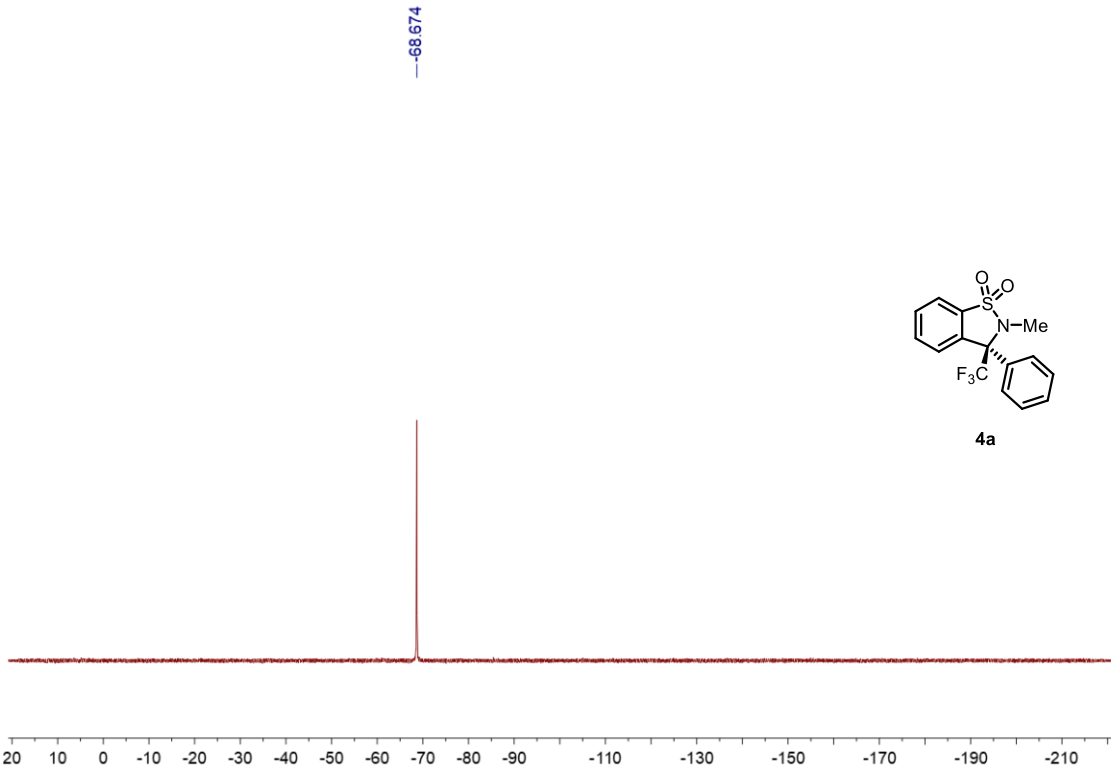
4a


-68.674
O
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-130
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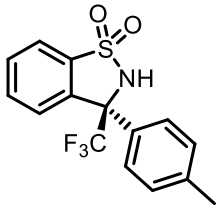
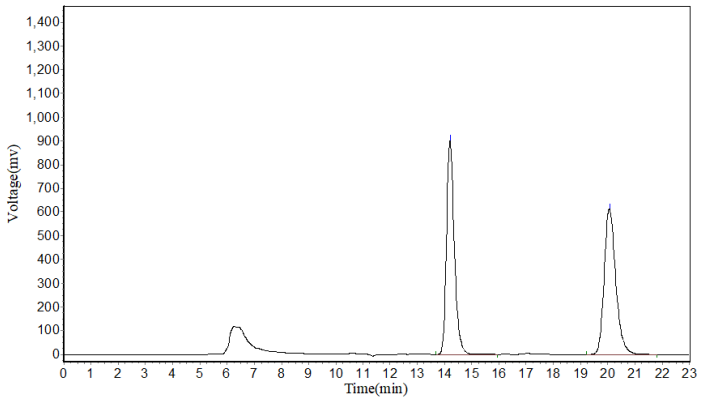
-190
-210

4a

7. HPLC Spectra

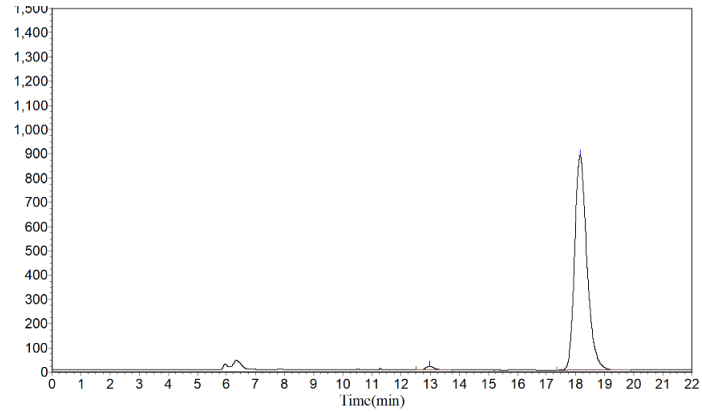


(*R*)-3-(p-tolyl)-3-(trifluoromethyl)-2,3-dihydrobenzo[*d*]isothiazole 1,1-dioxide (**3a**)
HPLC: Chiralpak IC column (250 mm); detected at 220 nm; hexane/*i*-propanol = 80/20; flow = 0.5 mL/min; Retention time: 13.0 min,18.2 min (major), 98% ee.



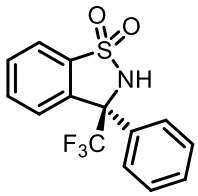
Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		14.198	901841.375	17965980.000	49.9989
2		20.057	613100.375	17966802.000	50.0011
Total			1514941.750	35932782.000	100.0000



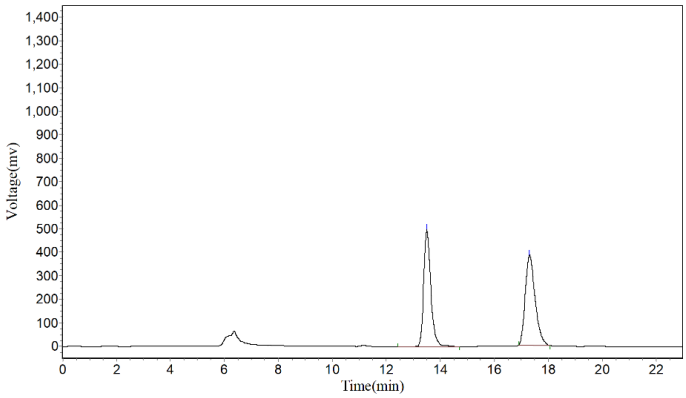
Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		12.977	13575.620	276406.125	1.0606
2		18.152	887099.750	25784884.000	98.9394
Total			900675.370	26061290.125	100.0000



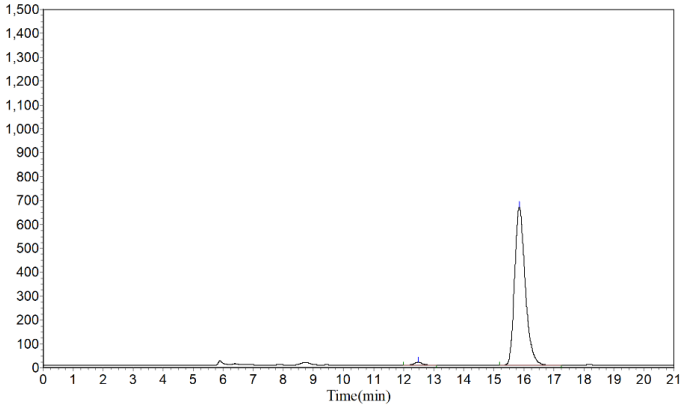
(*R*)-3-phenyl-3-(trifluoromethyl)-2,3-dihydrobenzo[*d*]isothiazole 1,1-dioxide (**3b**)

HPLC: Chiralpak IC column (250 mm); detected at 220 nm; hexane/*i*-propanol = 80/20; flow = 0.5 mL/min; Retention time: 12.5 min,15.8 min (major), 97% ee.



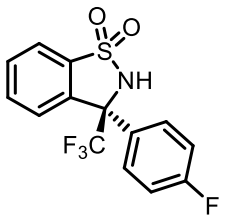
Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		13.500	498137.438	9125065.000	48.4950
2		17.307	383603.219	9691459.000	51.5050
Total			881740.656	18816524.000	100.0000



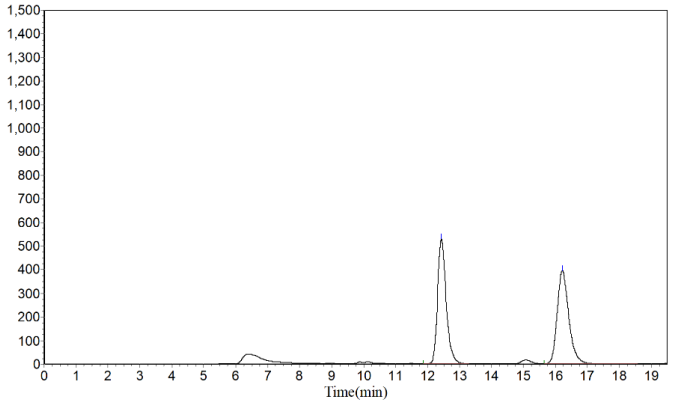
Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		12.488	12880.814	259835.031	1.5798
2		15.855	662246.688	16187396.000	98.4202
Total			675127.502	16447231.031	100.0000



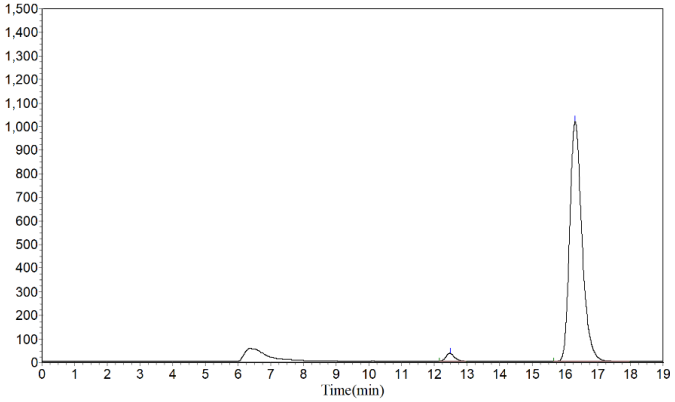
(*R*)-3-(4-fluorophenyl)-3-(trifluoromethyl)-2,3-dihydrobenzo[*d*]isothiazole 1,1-dioxide (**3c**)

HPLC: Chiralpak IC column (250 mm); detected at 220 nm; hexane/*i*-propanol = 80/20; flow = 0.5 mL/min; Retention time: 13.2 min (major),15.9 min, 96% ee.



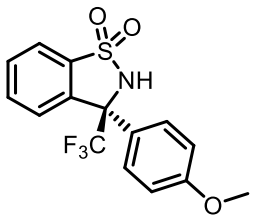
Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		12.440	531263.313	9873980.000	49.8674
2		16.223	394001.344	9926491.000	50.1326
Total			925264.656	19800471.000	100.0000



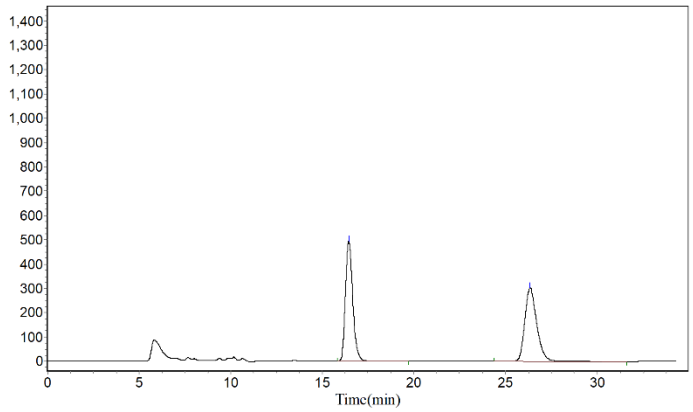
Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		12.473	33095.145	597479.438	2.2116
2		16.308	1018406.125	26418224.000	97.7884
Total			1051501.270	27015703.438	100.0000



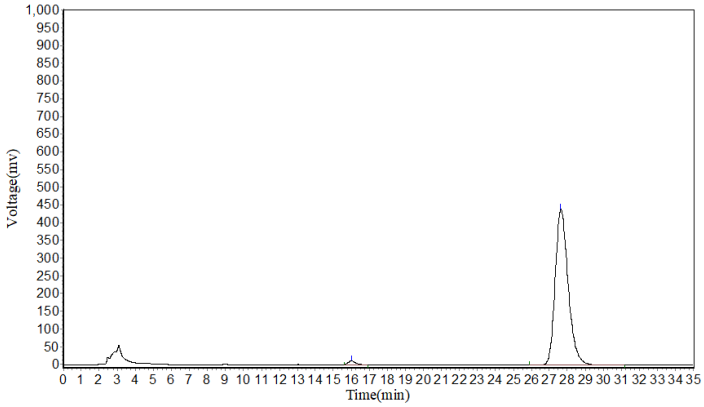
(*R*)-3-(4-methoxyphenyl)-3-(trifluoromethyl)-2,3-dihydrobenzo[*d*]isothiazole 1,1-dioxide (**3d**)

HPLC: Chiralpak IC column (250 mm); detected at 220 nm; hexane/*i*-propanol = 80/20; flow = 0.5 mL/min; Retention time: 16.0 min, 27.6 min (major), 97% ee.



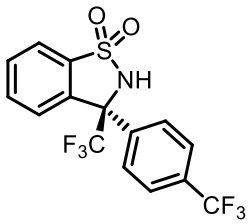
Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		16.440	493759.219	13684027.000	49.9752
2		26.340	303649.688	13697609.000	50.0248
Total			797408.906	27381636.000	100.0000



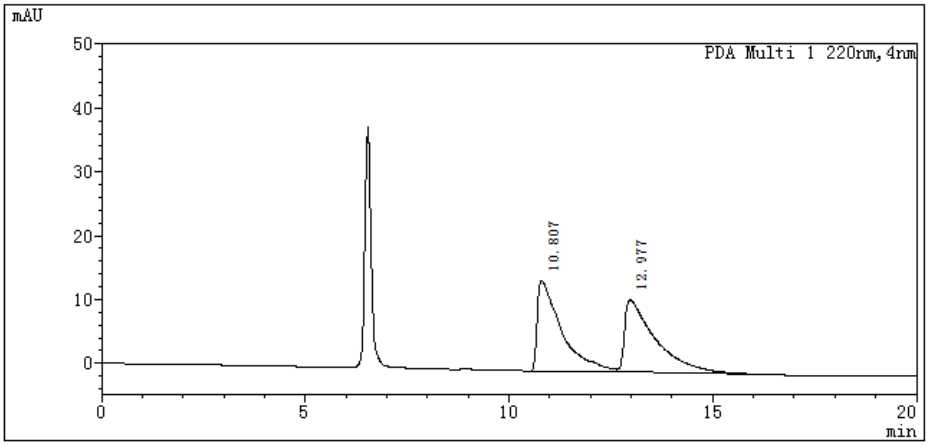
Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		16.000	10803.256	306413.406	1.3812
2		27.642	439217.688	21878174.000	98.6188
Total			450020.943	22184587.406	100.0000



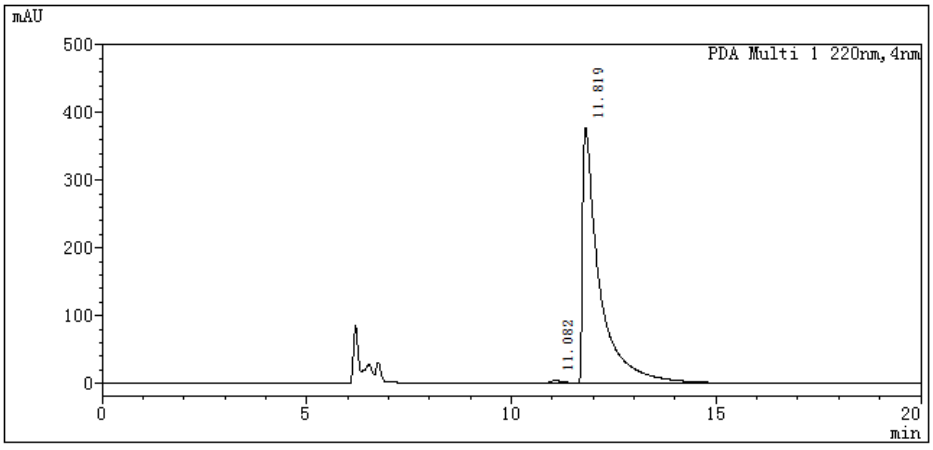
(*R*)-3-(trifluoromethyl)-3-(4-(trifluoromethyl)phenyl)-2,3-dihydrobenzo[*d*]isothiazole 1,1-dioxide (**3e**)

HPLC: Chiralpak IC column (250 mm); detected at 220 nm; hexane/*i*-propanol = 80/20; flow = 0.5 mL/min; Retention time: 11.1 min, 11.8 min (major), 98% ee.



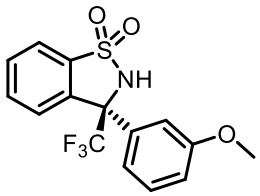
PDA Ch1 220nm

Peak No.	Ret Time	Height	Area	Conc.
1	10.807	14157	589325	49.437
2	12.977	11367	602751	50.563



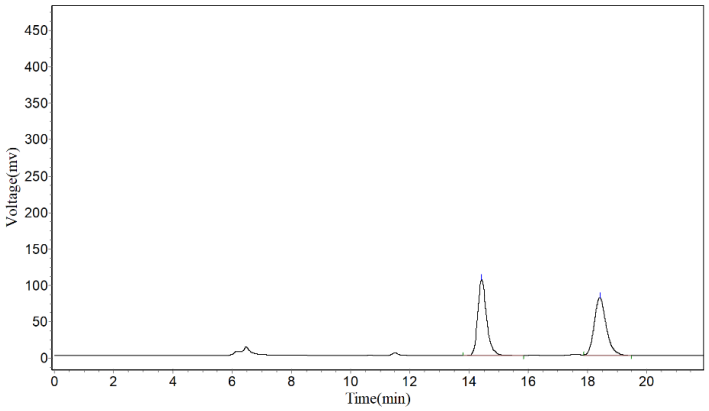
PDA Ch1 220nm

Peak No.	Ret Time	Height	Area	Conc.
1	11.082	4601	119335	1.067
2	11.819	378832	11069880	98.933



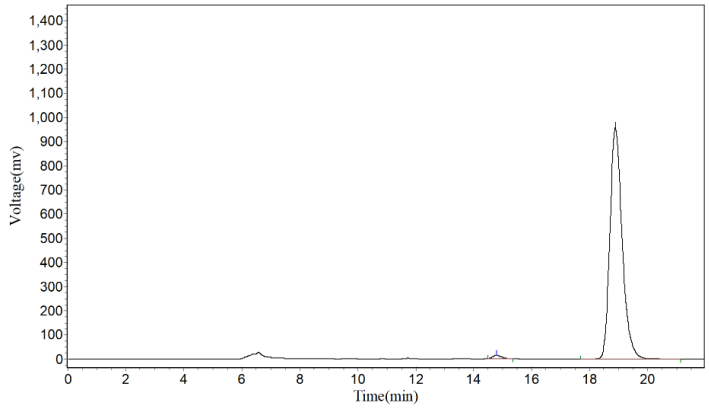
(*R*)-3-(3-methoxyphenyl)-3-(trifluoromethyl)-2,3-dihydrobenzo[*d*]isothiazole 1,1-dioxide (**3f**)

HPLC: Chiralpak IC column (250 mm); detected at 220 nm; hexane/*i*-propanol = 80/20; flow = 0.5 mL/min; Retention time: 14.8 min, 18.9 min (major), 98% ee.



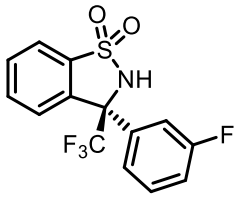
Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		14.425	103792.438	2154762.000	49.0703
2		18.410	79288.930	2236410.500	50.9297
Total			183081.367	4391172.500	100.0000



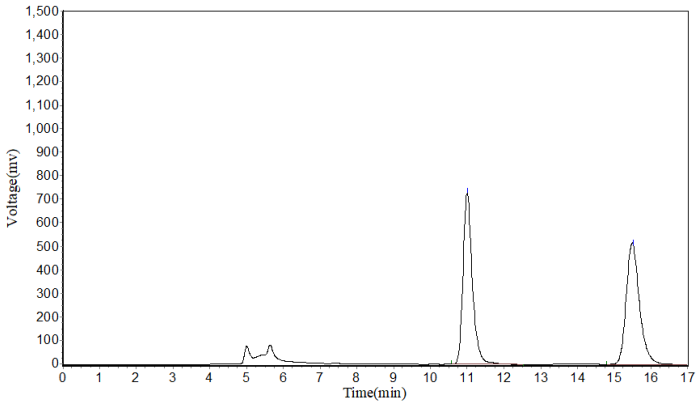
Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		14.793	14524.682	298458.000	1.0499
2		18.893	958368.250	28129030.000	98.9501
Total			972892.932	28427488.000	100.0000



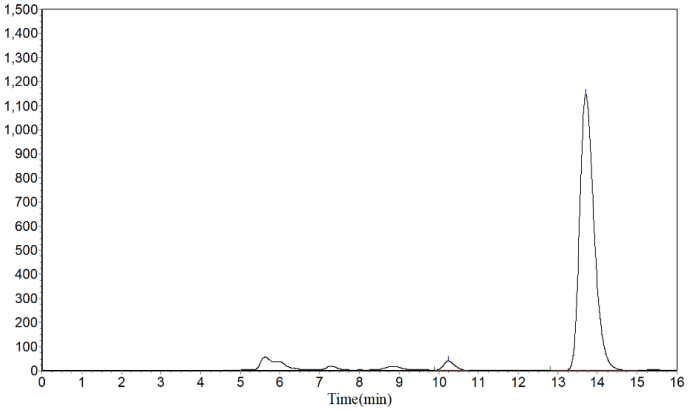
(*R*)-3-(3-fluorophenyl)-3-(trifluoromethyl)-2,3-dihydrobenzo[*d*]isothiazole 1,1-dioxide (**3g**)

HPLC: Chiralpak IC column (250 mm); detected at 220 nm; hexane/*i*-propanol = 80/20; flow = 0.5 mL/min; Retention time: 10.2 min, 13.7 min (major), 95% ee.



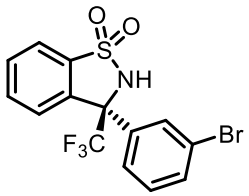
Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		11.007	724995.125	12809086.000	49.9735
2		15.523	512062.844	12822683.000	50.0265
Total			1237057.969	25631769.000	100.0000



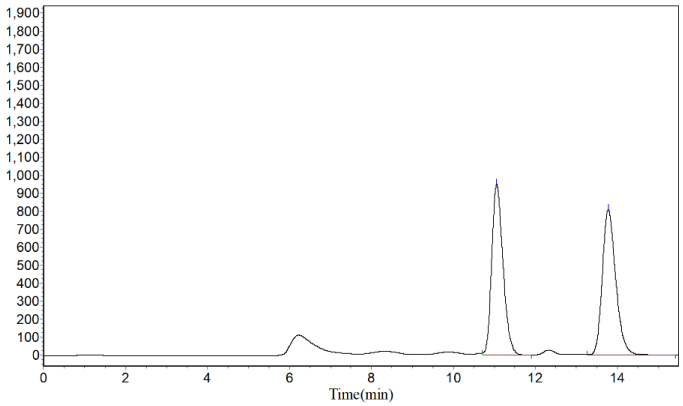
Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		10.240	37338.332	698951.813	2.3625
2		13.703	1146176.625	28780862.000	97.2803
Total			1186363.911	29585490.578	100.0000



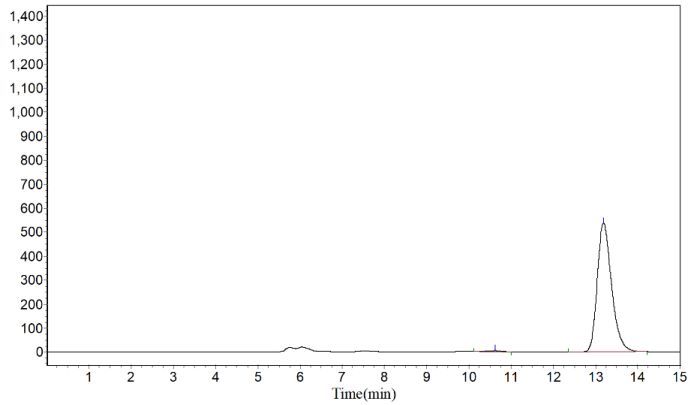
(*R*)-3-(3-bromophenyl)-3-(trifluoromethyl)-2,3-dihydrobenzo[*d*]isothiazole 1,1-dioxide (**3h**)

HPLC: Chiralpak IC column (250 mm); detected at 220 nm; hexane/*i*-propanol = 80/20; flow = 0.5 mL/min; Retention time: 10.6 min, 13.2 min (major), 98% ee.



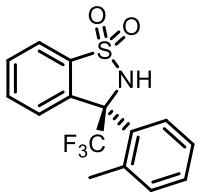
Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		11.057	946221.438	18102288.000	49.5837
2		13.782	806610.250	18406266.000	50.4163
Total			1752831.688	36508554.000	100.0000



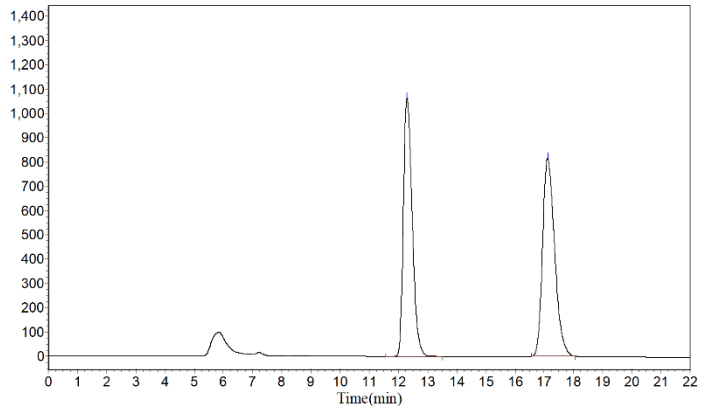
Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		10.625	5331.678	114667.703	0.8983
2		13.188	536597.813	12650589.000	99.1017
Total			541929.490	12765256.703	100.0000



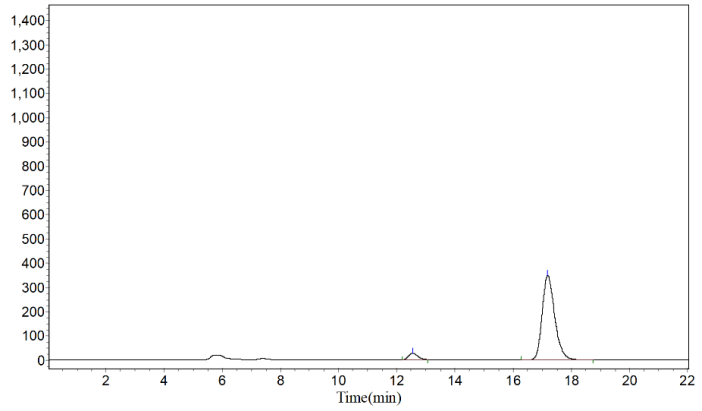
(*R*)-3-(o-tolyl)-3-(trifluoromethyl)-2,3-dihydrobenzo[*d*]isothiazole 1,1-dioxide (**3i**)

HPLC: Chiralpak IC column (250 mm); detected at 220 nm; hexane/*i*-propanol = 80/20; flow = 0.5 mL/min; Retention time: 12.5 min, 17.2 min (major), 90% ee.



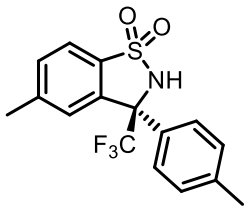
Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		12.295	1067193.750	22482048.000	48.9352
2		17.115	815159.500	23460434.000	51.0648
Total			1882353.250	45942482.000	100.0000



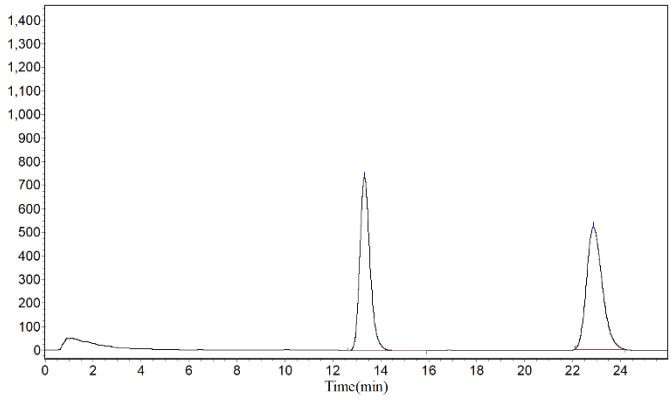
Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		12.547	27209.775	575848.375	5.2422
2		17.190	348888.188	10409069.000	94.7578
Total			376097.963	10984917.375	100.0000



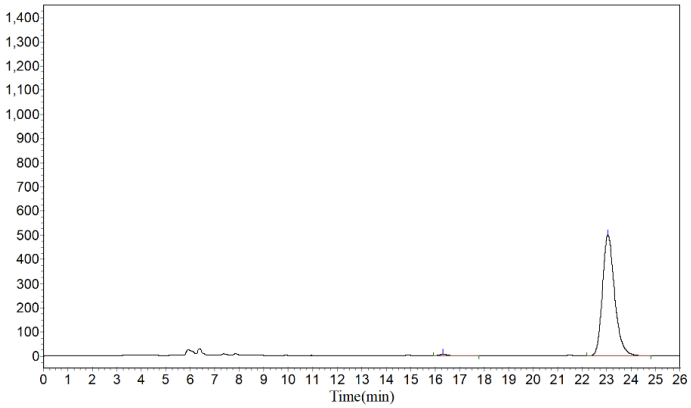
(*R*)-5-methyl-3-(p-tolyl)-3-(trifluoromethyl)-2,3-dihydrobenzo[*d*]isothiazole 1,1-dioxide (**3j**)

HPLC: Chiralpak IC column (250 mm); detected at 220 nm; hexane/*i*-propanol = 80/20; flow = 0.5 mL/min; Retention time: 16.3 min, 23.1 min (major), 98% ee.



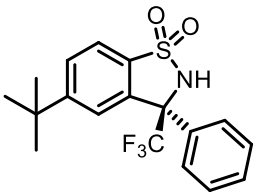
Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		13.320	736138.188	21742240.000	48.0681
2		22.880	518641.719	23489896.000	51.9319
Total			1254779.906	45232136.000	100.0000



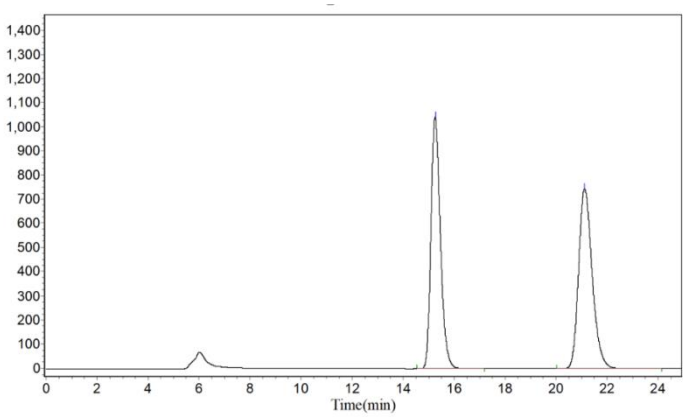
Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		16.323	5568.549	145505.813	0.8381
2		23.057	496530.156	17216182.000	99.1619
Total			502098.706	17361687.813	100.0000



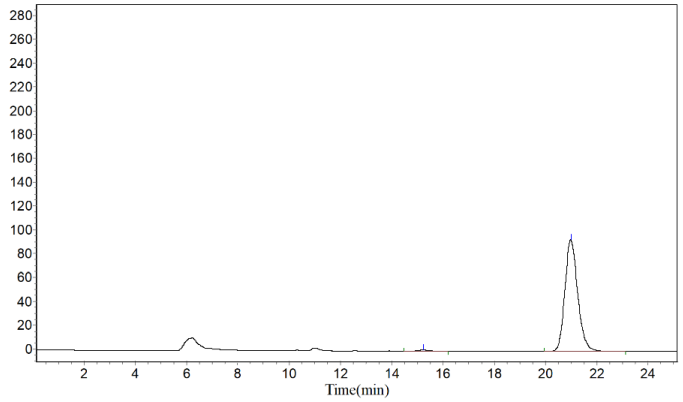
(*R*)-5-(tert-butyl)-3-phenyl-3-(trifluoromethyl)-2,3-dihydrobenzo[*d*]isothiazole 1,1-dioxide (**3k**):

HPLC: Chiralpak IC column (250 mm); detected at 220 nm; hexane/*i*-propanol = 80/20; flow = 0.5 mL/min; Retention time: 15.2 min, 21.0 min (major), 98% ee.



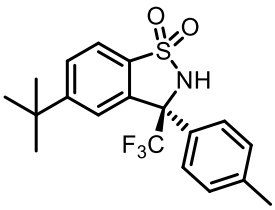
Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		15.257	1041891.875	26755734.000	49.1922
2		21.123	744068.000	27634420.000	50.8078
Total			1785959.875	54390154.000	100.0000



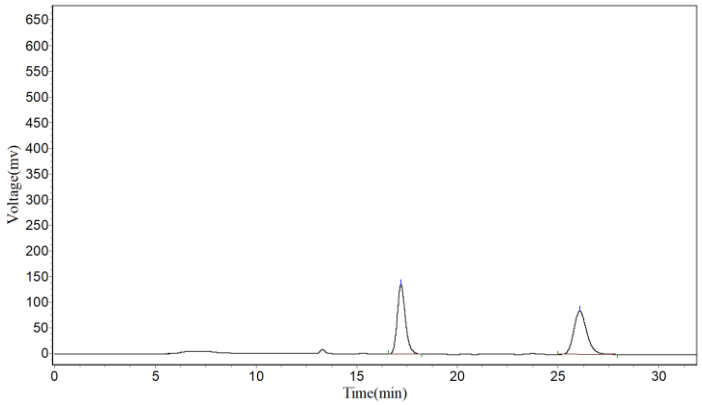
Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		15.217	835.408	22271.545	0.6831
2		20.985	93721.500	3238326.750	99.3169
Total			94556.908	3260598.295	100.0000



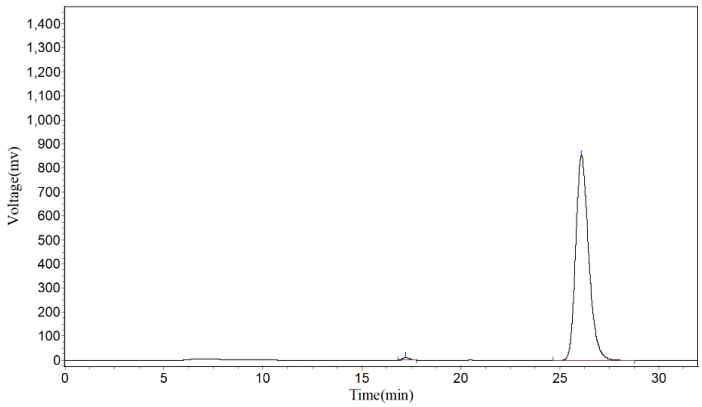
(*R*)-5-(tert-butyl)-3-(p-tolyl)-3-(trifluoromethyl)-2,3-dihydrobenzo[*d*]isothiazole 1,1-dioxide (**3l**):

HPLC: Chiralpak IC column (250 mm); detected at 220 nm; hexane/*i*-propanol = 80/20; flow = 0.5 mL/min; Retention time: 17.2 min, 26.1 min (major), 99% ee.



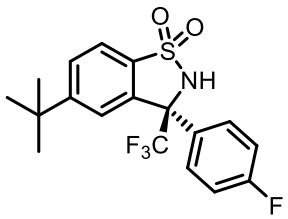
Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		17.195	135441.188	3780752.000	50.3118
2		26.078	84296.414	3733896.000	49.6882
Total			219737.602	7514648.000	100.0000



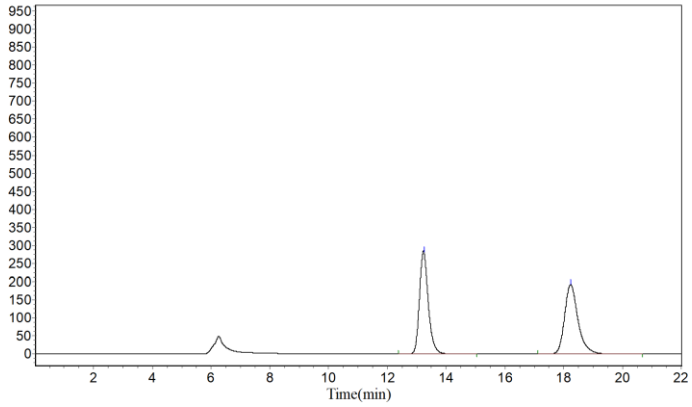
Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		17.223	9034.423	231464.859	0.5950
2		26.093	852128.313	38670804.000	99.4050
Total			861162.735	38902268.859	100.0000



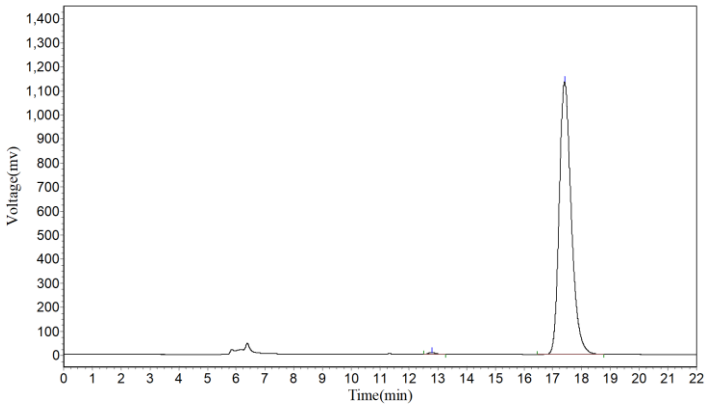
(*R*)-5-(tert-butyl)-3-(4-fluorophenyl)-3-(trifluoromethyl)-2,3-dihydrobenzo[*d*]isothiazole 1,1-dioxide (**3m**):

HPLC: Chiralpak IC column (250 mm); detected at 220 nm; hexane/*i*-propanol = 80/20; flow = 0.5 mL/min; Retention time: 12.8 min, 17.4 min (major), 99% ee.



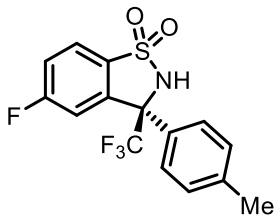
Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		13.248	283777.625	5937323.000	49.4868
2		18.248	191920.594	6060464.500	50.5132
Total			475698.219	11997787.500	100.0000



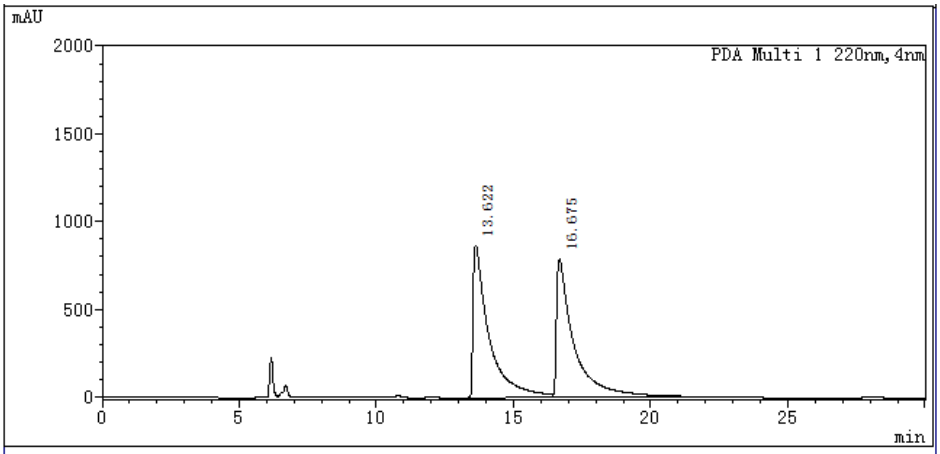
Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		12.793	6873.782	127779.406	0.3890
2		17.408	1133980.125	32724116.000	99.6110
Total			1140853.907	32851895.406	100.0000



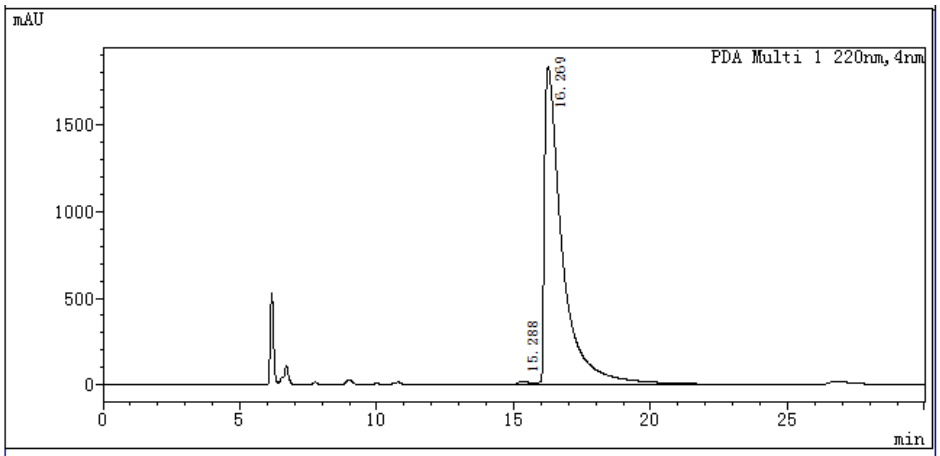
(*R*)-5-fluoro-3-(p-tolyl)-3-(trifluoromethyl)-2,3-dihydrobenzo[*d*]isothiazole 1,1-dioxide (**3n**):

HPLC: Chiralpak IC column (250 mm); detected at 220 nm; hexane/*i*-propanol = 80/20; flow = 0.5 mL/min; Retention time: 13.6 min, 16.6 min (major), 99% ee.



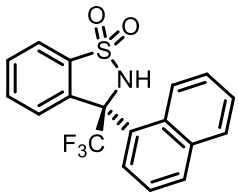
PDA Ch1 220nm

Peak No.	Ret Time	Height	Area	Conc.
1	13.622	868512	35039363	49.783
2	16.675	786578	35345131	50.217



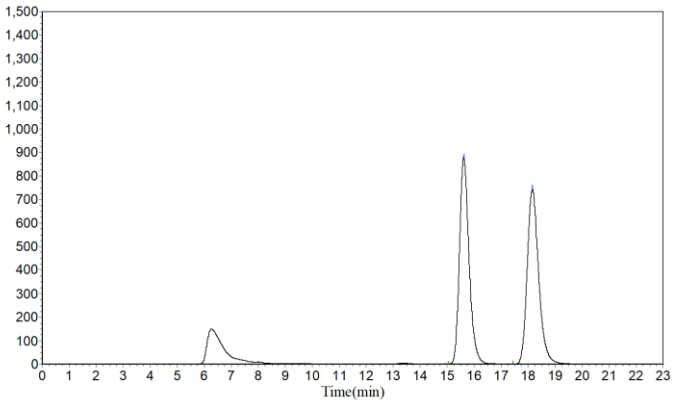
PDA Ch1 220nm

Peak No.	Ret Time	Height	Area	Conc.
1	15.288	17616	560348	0.668
2	16.269	1838018	83336829	99.332



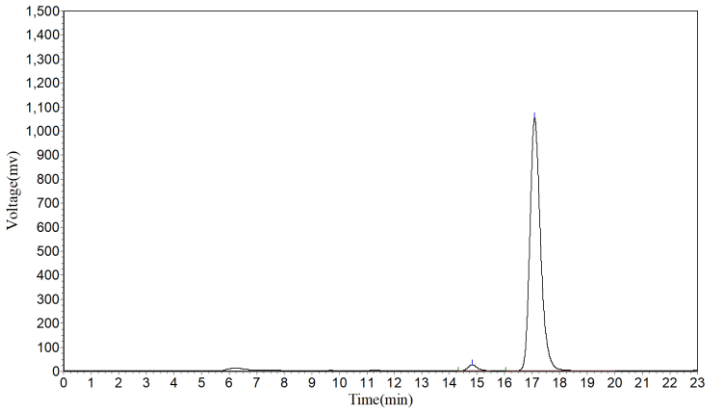
(*R*)-3-(naphthalen-1-yl)-3-(trifluoromethyl)-2,3-dihydrobenzo[*d*]isothiazole 1,1-dioxide (**3o**):

HPLC: Chiralpak IC column (250 mm); detected at 220 nm; hexane/*i*-propanol = 80/20; flow = 0.5 mL/min; Retention time: 14.8 min, 17.1 min (major), 96% ee.



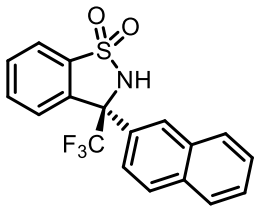
Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		15.632	878205.875	21823542.000	49.7480
2		18.165	742255.375	22044614.000	50.2520
Total			1620461.250	43868156.000	100.0000



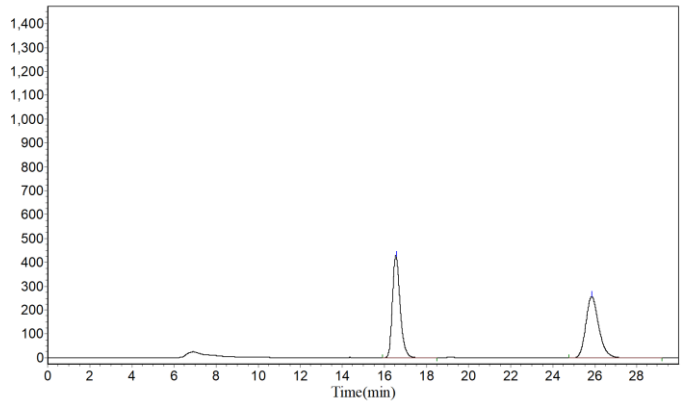
Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		14.820	24735.000	554795.938	1.9372
2		17.092	1052207.500	28083906.000	98.0628
Total			1076942.500	28638701.938	100.0000



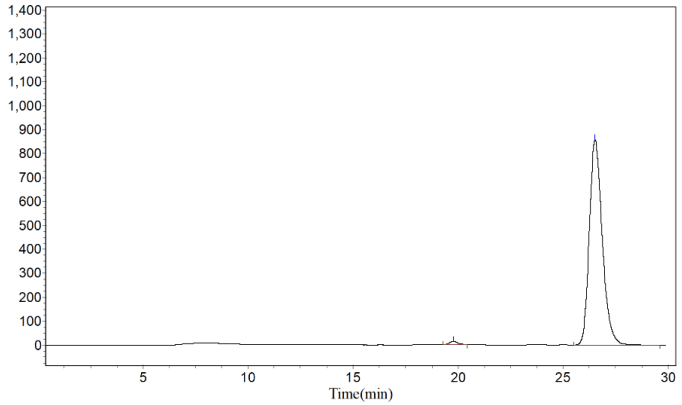
(*R*)-3-(naphthalen-2-yl)-3-(trifluoromethyl)-2,3-dihydrobenzo[*d*]isothiazole 1,1-dioxide (**3p**)

HPLC: Chiralpak IC column (250 mm); detected at 220 nm; hexane/*i*-propanol = 80/20; flow = 0.5 mL/min; Retention time: 16.6 min, 25.8 min (major), 98% ee.



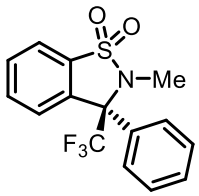
Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		16.557	429471.344	10941731.000	49.6965
2		25.857	257457.578	11075395.000	50.3035
Total			686928.922	22017126.000	100.0000



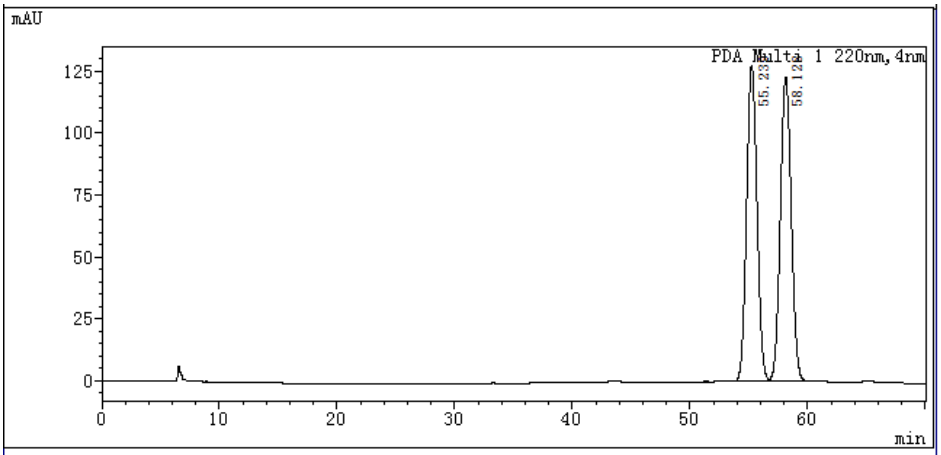
Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		19.783	15234.407	438935.000	1.1800
2		26.523	857986.250	36758928.000	98.8200
Total			873220.657	37197863.000	100.0000



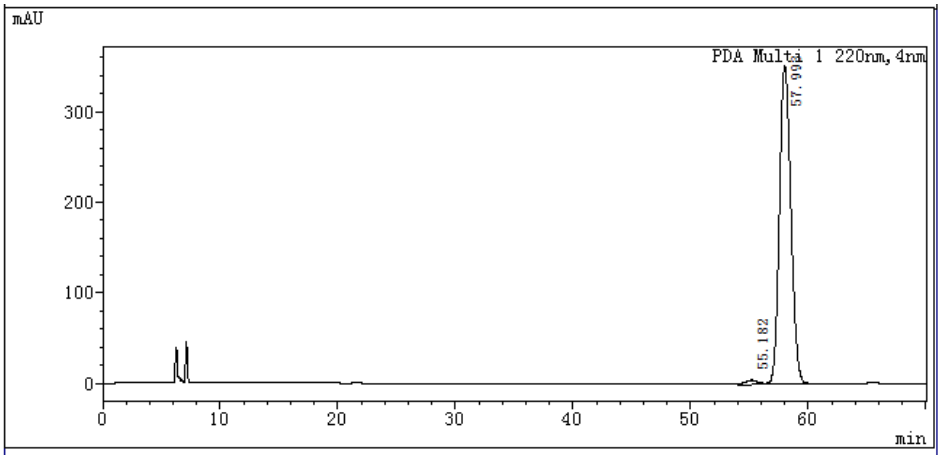
(*R*)-2-methyl-3-phenyl-3-(trifluoromethyl)-2,3-dihydrobenzo[*d*]isothiazole 1,1-dioxide (**4a**).

HPLC: Chiralpak IC column (250 mm); detected at 220 nm; hexane/*i*-propanol = 95/5; flow = 0.5 mL/min; Retention time: 55.2 min, 58.1 min (major), 97% ee.



PDA Ch1 220nm

Peak No.	Ret Time	Height	Area	Conc.
1	55.239	127500	7857527	49.716
2	58.128	122588	7947200	50.284



PDA Ch1 220nm

Peak No.	Ret Time	Height	Area	Conc.
1	55.182	4643	357751	1.484
2	57.993	352091	23746418	98.516