Supporting Information

Asymmetric synthesis of (3S,1’S)-3-(1-amino-2,2,2-trifluoroethyl)-1-(alkyl)-indolin-2-one derivatives by additions of (S)-N-t-butylsulfinyl-3,3,3-trifluoroacetaldimine to 1-(alkyl)-indolin-2-ones

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1. General information

Oxoindoles were synthesized according to literature\(^1,2\). Sulfinylimine \(1\) was synthesized due to literature\(^3\). Other reagents were obtained from commercial suppliers and used without further purification. The reactions were conducted in a closed system in an atmosphere of \(\text{N}_2\) and were monitored by TLC. Solvents were dried and distilled prior to use. Flash chromatography was performed using silica gel 60 (300–400 mesh). Thin layer chromatography was carried out on silica gel 60 F-254 TLC plates of 20 cm \(\times\) 20 cm. \(^1\text{H}, \, ^{13}\text{C}\) and \(^{19}\text{F}\) NMR spectra were recorded on a Bruker AVANCE400M spectrometer. Melting points were uncorrected. Values of optical rotation were measured on a Rudolph Automatic Polarimeter A21101. Infrared spectra were obtained on a Bruker Vector 22 in KBr pellets. HRMS were conducted on an Agilent 6540Q-TOF LC/MS equipped with an electrospray ionization (ESI) probe operating in positive or negative ion mode.

Reference


2. Typical procedure for asymmetric addition of sulfinylimine

Into an oven-dried reaction vial flushed with \(\text{N}_2\) was taken oxoindole \(4\) (0.6 mmol) and anhydrous DCM (3.0 mL). The reaction vial was cooled to \(-78^\circ\text{C}\) and LDA (2 M in Hexene, 0.36 mL) was added dropwise with stirring. After 1 hour at \(-78^\circ\text{C}\), sulfinyl-imine \(1\) (0.5 mmol) dissolved in anhydrous DCM (2 mL) was pre-cooled to \(-78^\circ\text{C}\), and then added dropwise to the reaction mixture. Stirring was continued at \(-78^\circ\text{C}\) for 5 h, and then the reaction was quenched with saturated \(\text{NH}_4\text{Cl}\) (3.0 mL), followed by \(\text{H}_2\text{O}\) (3.0 mL) and the mixture was brought to room temperature. The
organic layer was taken and the aqueous layer was extracted with EtOAc (2 × 20 mL). The combined organic layers were washed with water (1 × 30 mL) and brine solution (1 × 30 mL) and dried over anhydrous Na₂SO₄. The solvent was evaporated, and the crude mixture was charged onto silica gel and purified by flash chromatography to furnish the corresponding product.

3. Characterization data of compounds 5a-5e, 7a-7l

(S)-2-methyl-N-((S)-2,2,2-trifluoro-1-((S)-1-methyl-2-oxoindolin-3-yl)ethyl)propane-2-sulfinamide (5a)
White solid (153.3 mg, 88%), mp 159-163 °C, [α]D²⁵ = -50.9 (c = 1.05, CHCl₃). (major isomer) ¹H NMR (400 MHz, CDCl₃) δ 7.38 (d, J = 7.0 Hz, 2H), 7.12 (t, J = 6.9 Hz, 1H), 6.89 (d, J = 7.2 Hz, 1H), 4.69-4.49 (m, 1H), 3.86 (s, 1H), 3.43 (d, J = 10.4 Hz, 1H), 3.19 (s, 3H), 0.97 (s, 9H). ¹⁹F NMR (376 MHz, CDCl₃) δ -71.71. ¹³C NMR (101 MHz, CDCl₃) δ 174.1, 145.2, 129.7, 125.7, 124.8 (q, JFC = 283.4 Hz), 123.1, 121.8, 108.6, 59.0 (q, JFC = 31.3 Hz), 57.1, 46.4, 26.4, 22.1. IR (cm⁻¹): ν 3242, 3066, 2969, 2928, 1704, 1614, 1498, 1472, 1430, 1382, 1340, 1244, 1170, 1115, 1082, 769, 658, 541. HRMS (ESI):[M+Na⁺] calcd for C₁₅H₁₉F₃N₂O₂SNa: 371.1017, found: 371.1019.

(S)-N-((S)-1-((S)-1-ethyl-2-oxoindolin-3-yl)-2,2,2-trifluoroethyl)-2-methylpropane-2-sulfinamide (5b)
Yellow oil (168.5 mg, 93%), [α]D²⁵ = -22.7 (c = 3.16, CHCl₃). (major isomer) ¹H NMR (400 MHz, CDCl₃) δ 7.37 (t, J = 8.0 Hz, 2H), 7.10 (t, J = 7.4 Hz, 1H), 6.91 (d, J = 7.8 Hz, 1H), 4.57 (dq, J = 10.5, 8.1, 2.3 Hz, 1H), 3.80 (m, 1H), 3.69 (m, 1H), 3.58 (d, J = 10.9 Hz, 1H), 1.27 (t, J = 7.2 Hz, 3H), 0.99 (s, 9H). ¹⁹F NMR (376 MHz, CDCl₃) δ -71.64. ¹³C NMR (101 MHz, CDCl₃) δ 173.7, 144.3, 129.6, 124.9 (q, JFC = 283.6 Hz), 125.7, 122.9, 122.0, 108.7, 58.7 (q, JFC = 31.2 Hz), 57.2, 46.3, 35.1, 22.1, 12.5. IR (cm⁻¹): ν 3234, 3052, 2975, 2932, 2872, 1696, 1611, 1491, 1466, 1373, 1341, 1269, 1
(S)-2-methyl-N-((S)-2,2,2-trifluoro-1-((S)-1-isopropyl-2-oxoindolin-3-yl)ethyl)propane-2-sulfinamide (5c)

Yellow oil (148.7 mg, 79%), $[\alpha]_D^{25} = -14.7$ (c = 1.65, CHCl$_3$). (major isomer)
$^1$H NMR (400 MHz, CDCl$_3$) δ 7.38-7.28 (m, 2H), 7.10-6.99 (m, 2H), 4.64-4.52 (m, 2H), 3.84-3.76 (m, 2H), 1.47 (t, $J = 6.5$ Hz, 6H), 1.02 (s, 9H).
$^{19}$F NMR (376 MHz, CDCl$_3$) δ -71.44.
$^{13}$C NMR (101 MHz, CDCl$_3$) δ 173.8, 143.7, 129.2, 125.5, 125.0 (q, $J_{FC} = 283.8$ Hz), 122.5, 122.4, 110.3, 58.3 (q, $J_{FC} = 3.0$ Hz), 57.2, 46.3, 44.3, 22.2, 19.3, 19.1. IR (cm$^{-1}$): ν 3230, 3058, 2976, 2925, 2872, 2853, 1712, 1705, 1650, 1610, 1486, 1468, 1401, 1361, 1259, 1233, 1204, 1170, 1120, 1089, 894, 751, 657, 442. HRMS (ESI): [M+Na$^+$] calcd for C$_{17}$H$_{23}$F$_3$N$_2$O$_2$SNa: 399.1330, found: 399.1331.

(S)-N-((S)-1-((S)-1-benzyl-2-oxoindolin-3-yl)-2,2,2-trifluoroethyl)-2-methylpropane-2-sulfinamide (5d)

Yellow oil (199.5 mg, 94%), $[\alpha]_D^{25} = -40.4$ (c = 4.00, CHCl$_3$). (major isomer)
$^1$H NMR (400 MHz, CDCl$_3$) δ 7.38-7.21 (m, 7H), 7.07 (t, $J = 7.5$ Hz, 1H), 6.83 (d, $J = 7.0$ Hz, 1H), 5.08 (d, $J = 15.5$ Hz, 1H), 4.65 (d, $J = 15.5$ Hz,1H), 4.68-4.59 (m, 1H), 3.96 (s, 1H), 3.75 (d, $J = 10.8$ Hz,1H), 0.97 (s,9H). $^{19}$F NMR (376 MHz, CDCl$_3$) δ -71.49. $^{13}$C NMR (101 MHz, CDCl$_3$) δ 174.3, 144.3, 135.1, 129.5, 128.9, 127.9, 127.6, 125.5, 124.9 (q, $J_{FC} = 283.6$ Hz), 124.7, 12.41, 123.1, 121.9, 109.6, 58.5 (q, $J_{FC} = 31.1$ Hz), 57.2, 46.4, 44.2, 22.1. IR (cm$^{-1}$): ν 3471, 3230, 3062, 2959, 2925, 2854, 1713, 1613, 1489, 1468, 1456, 1438, 1366, 1270, 1252, 1199, 1170, 1122, 1082, 1017, 923, 910, 893, 820, 752, 735, 698, 663, 638, 550, 443. HRMS (ESI): [M+Na$^+$] calcd for C$_{21}$H$_{23}$F$_3$N$_2$O$_2$SNa: 447.1330, found: 447.1330.
(S)-2-methyl-N-((S)-2,2,2-trifluoro-1-((S)-2-oxo-1-phenylindolin-3-yl)ethyl)propane-2-sulfinamide (5e)

Yellow oil (201.0 mg, 95%), $[\alpha]^{25}_D = -82.1$ ($c = 1.02$, CHCl$_3$). (major isomer)

$^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.55-7.35 (m, 6H), 7.32-7.25 (m, 1H), 7.16-7.13 (m, 1H), 6.84 (d, $J = 7.9$ Hz, 1H), 4.71-4.62 (m, 1H), 4.05 (s, 1H), 3.80 (d, $J = 10.9$ Hz, 1H), 1.04 (s, 9H).

$^{19}$F NMR (376 MHz, CDCl$_3$) $\delta$ -71.37.

$^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 173.5, 145.0, 133.8, 129.8, 129.5, 128.4, 126.4, 126.2, 125.7, 124.9 (q, $J_{FC} = 283.6$ Hz), 124.6, 124.3, 123.6, 121.8, 110.1, 58.7 (q, $^{2}J_{FC} = 31.1$ Hz), 57.2, 46.7, 22.3.

IR (cm$^{-1}$): $\nu$ 3230, 3062, 2959, 2926, 2876, 1724, 1670, 1653, 1594, 1483, 1466, 1420, 1373, 1330, 1254, 1201, 1173, 1154, 1095, 1029, 1002, 752, 696, 663, 608, 489, 445.

HRMS (ESI): [M+Na$^+$] calcd for C$_{20}$H$_{21}$F$_3$N$_2$O$_2$SNa: 433.1174, found: 433.1173.

(S)-N-((S)-1-((S)-4-chloro-1-methyl-2-oxoindolin-3-yl)-2,2,2-trifluoroethyl)-2-methylpropane-2-sulfinamide (7a)

Yellow oil (185.7 mg, 97%), $[\alpha]^{25}_D = +28.0$ ($c = 2.91$, CHCl$_3$). (major isomer)

$^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.21 (t, $J = 8.1$ Hz, 1H), 6.96 (d, $J = 8.4$ Hz, 1H), 6.71 (d, $J = 7.8$ Hz, 1H), 5.98 (d, $J = 10.5$ Hz, 1H), 5.09-4.95 (m, 1H), 3.86 (s, 1H), 3.13 (s, 3H), 1.22 (s, 9H).

$^{19}$F NMR (376 MHz, CDCl$_3$) $\delta$ -70.85.

$^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 174.0, 145.0, 131.1, 130.4, 124.6 (q, $J_{FC} = 283.4$ Hz) 123.6, 121.4, 107.2, 57.4, 54.4 (q, $^{2}J_{FC} = 29.8$ Hz), 45.8, 26.5, 22.3.

IR (cm$^{-1}$): $\nu$ 3264, 3062, 2958, 2924, 2870, 2854, 1712, 1705, 1611, 1592, 1463, 1422, 1365, 1343, 1295, 1273, 1249, 1194, 1168, 1124, 1112, 1092, 1018, 933, 906, 772, 669, 568, 506, 461.

HRMS (ESI): [M+Na$^+$] calcd for C$_{15}$H$_{18}$BrF$_3$N$_2$O$_2$SNa: 405.0627, found: 405.0625.

(S)-N-((S)-1-((S)-4-bromo-1-methyl-2-oxoindolin-3-yl)-2,2,2-trifluoroethyl)-2-methylpropane-2-sulfinamide
Yellow oil (194.4 mg, 91%), $[\alpha]_{D}^{25} = +27.0$ ($c = 1.45$, CHCl$_3$). (major isomer)

$^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.24-7.21 (m, 2H), 6.84-6.82 (m, 1H), 6.11 (d, $J = 10.48$ Hz, 1H), 5.23 (m, 1H), 3.91 (d, $J = 4.7$ Hz, 1H), 3.21 (s, 3H), 1.32 (s, 9H).

$^{19}$F NMR (376 MHz, CDCl$_3$) $\delta$ -70.83.

$^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 174.0, 145.1, 130.6, 126.6, 124.6 (q, $J_{CF} = 284.5$ Hz) 123.6, 119.5, 107.7, 57.5, 54.0 (q, $^2J_{CF} = 29.9$ Hz), 47.0, 26.5, 22.4. IR (cm$^{-1}$): $\nu$ 3261, 3060, 2959, 2928, 2870, 1708, 1608, 1583, 1459, 1423, 1364, 1344, 1275, 1247, 1193, 1168, 1124, 1103, 928, 769, 667, 562, 500. HRMS (ESI): [M+Na$^+$] calcd for C$_{15}$H$_{19}$BrF$_3$N$_2$O$_2$SNa: 449.0122, found: 449.0121.

White solid (170.3 mg, 93%), mp 158-162 $^\circ$C, $[\alpha]_{D}^{25} = -43.5$ ($c = 1.09$, CHCl$_3$). (major isomer)

$^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.15-7.08 (m, 2H), 6.82 (d, $J = 8.5$, 4.2 Hz, 1H), 4.59 (dqd, $J = 10.5$, 8.1, 2.3 Hz, 1H), 3.85 (s, 1H), 3.55 (d, $J = 10.8$ Hz, 1H), 3.18 (s, 3H), 1.00 (s, 9H).

$^{19}$F NMR (376 MHz, CDCl$_3$) $\delta$ -71.59, -119.21.

$^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 173.6, 159.2 (q, $J = 242.0$ Hz), 141.2 (d, $J = 20$ Hz), 124.7 (q, $J_{CF} = 283.2$ Hz), 123.5 (d, $J = 8.5$ Hz), 116.0 (d, $J = 23.4$ Hz), 114.0 (dq, $J = 25.6$ Hz, 2 Hz), 109.0 (d, $J = 8.2$ Hz), 58.8 (q, $^2J_{CF} = 31.3$ Hz), 57.2, 46.8, 26.6, 22.1. IR (cm$^{-1}$): $\nu$ 3264, 2967, 2924, 2873, 1711, 1625, 1479, 1472, 1458, 1428, 1372, 1339, 1282, 1244, 1201, 1176, 1150, 1120, 1083, 998, 939, 924, 864, 829, 790, 758, 706, 682, 666, 559. HRMS (ESI): [M+Na$^+$] calcd for C$_{15}$H$_{18}$F$_4$N$_2$O$_2$SNa: 389.0923, found: 389.0923.

White solid (176.1 mg, 92%), mp 179-184 $^\circ$C, $[\alpha]_{D}^{25} = +18.6$ ($c = 0.44$, CHCl$_3$). (major isomer) $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.38-7.34 (m, 2H), 6.83 (d, $J = 8.2$ Hz, 1H), 4.58 (dqd, $J = 10.5$, 8.1, 2.3 Hz, 1H), 3.85 (d, $J = 1.0$ Hz, 1H), 3.60 (d, $J = 10.8$ Hz, 1H), 3.18 (s, 3H), 1.00 (s, 9H). $^{19}$F NMR (376 MHz, CDCl$_3$) $\delta$ -71.53. $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 173.5, 143.7, 129.6, 128.5, 126.2 (q, $J = 3.3$ Hz), 124.7 (q, $J_{CF} = 283.2$ Hz), 123.5, 109.4, 58.8 (q, $^2J_{CF}$...
(S)-N-((S)-1-((S)-5-bromo-1-methyl-2-oxoindolin-3-yl)-2,2,2-trifluoroethyl)-2-methylpropane-2-sulfinamide (7e)
White solid (194.3 mg, 91%), mp 187-192 °C, [α]_D^25 = +39.0 (c = 1.01, CHCl_3). (major isomer) ¹H NMR (400 MHz, CDCl_3) δ 7.53-7.49 (m, 2H), 6.78 (d, J = 8.3 Hz, 1H), 4.62-4.53 (m, 1H), 3.86 (s, 1H), 3.61 (d, J = 10.8 Hz, 1H), 3.18 (s, 3H), 1.00 (s, 9H). ¹⁹F NMR (376 MHz, CDCl_3) δ -71.54. ¹³C NMR (101 MHz, CDCl_3) δ 173.4, 144.2, 132.6, 128.9 (q, J_{FC} = 3.4 Hz), 124.7 (q, J_{FC} = 283.4 Hz), 123.9, 115.8, 109.9, 58.8 (q, J_{FC} = 31.3 Hz), 57.2, 46.4, 26.6, 22.1. IR (cm⁻¹): ν 3277, 3249, 2961, 2923, 2870, 1708, 1669, 1610, 1488, 1454, 1428, 1369, 1334, 1288, 1245, 1175, 1136, 1085, 938, 865, 832, 785, 661, 635, 549. HRMS (ESI): [M+Na⁺] calcd for C_{15}H_{18}^{35}ClF_3N_2O_2SNa: 449.0122, found: 449.0120.

(S)-methyl 3-((S)-1-((S)-1,1-dimethylethylsulfinamido)-2,2,2-trifluoroethyl)-1-methyl-2-oxoindoline-5-carboxylate (7f)
White solid (182.7 mg, 90%), mp 183-188 °C, [α]_D^25 = +32.5 (c = 0.86, CHCl_3). (major isomer) ¹H NMR (400 MHz, CDCl_3) δ 8.14 (d, J = 8.1 Hz, 1H), 8.04 (s, 1H), 6.94 (d, J = 8.3 Hz, 1H), 4.73-4.49 (m, 1H), 3.92 (s, 3H), 3.90 (s, 1H), 3.66 (d, J = 10.8 Hz, 1H), 3.23 (s, 3H), 0.99 (s, 9H). ¹⁹F NMR (376 MHz, CDCl_3) δ -71.59. ¹³C NMR (101 MHz, CDCl_3) δ 174.4, 166.4, 149.0, 132.3, 126.8, 125.2, 124.7 (q, J_{FC} = 283.4 Hz), 122.0, 108.2, 58.8 (q, J_{FC} = 31.3 Hz), 57.2, 52.3, 46.3, 26.7, 22.1. IR (cm⁻¹): ν 3259, 2953, 2925, 1713, 1616, 1499, 1454, 1428, 1369, 1357, 1288, 1245, 1175, 1136, 1121, 1079, 975, 722, 663, 549. HRMS (ESI): [M+Na⁺] calcd for C_{17}H_{21}F_3N_2O_4SNa: 429.1072, found: 429.1071.
(S)-N-((S)-1-((S)-1,5-dimethyl-2-oxoindolin-3-yl)-2,2,2-trifluoroethyl)-2-methylpropane-2-sulfinamide (7g)
Light yellow solid (177.4 mg, 98%), mp 148-150 °C, \([\alpha]_D^{25} = -11.4\ (c = 1.02, \text{CHCl}_3)\). (major isomer) \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.18 (d, \(J = 6.2\) Hz, 2H), 6.77 (d, \(J = 8.4\) Hz, 1H), 4.55 (dqd, \(J = 10.4, 8.1, 2.2\) Hz, 1H), 3.81 (s, 1H), 3.43 (d, \(J = 11.1\) Hz, 1H), 3.17 (s, 3H), 2.35 (s, 3H), 0.98 (s, 9H). \(^{19}\)F NMR (376 MHz, CDCl\(_3\)) \(\delta\) -71.79. \(^{13}\)C NMR (101 MHz, CDCl\(_3\)) \(\delta\) 174.0, 142.8, 132.8, 129.9, 126.5, 124.8 (q, \(J_{FC} = 283.5\) Hz), 121.7, 108.3, 59.0 (q, \(2J_{FC} = 31.3\)Hz), 57.2, 46.4, 26.5, 22.1, 21.2. IR (cm\(^{-1}\)): \(\nu\) 3257, 2987, 2922, 2852,1706, 1621, 1604, 1500, 1467, 1371, 1337, 1287, 1246, 1199, 1170, 1118, 1085,938, 835, 825, 664, 553. HRMS (ESI): [M+Na\(^+\)] calcd for C\(_{16}\)H\(_{21}\)F\(_3\)N\(_2\)O\(_2\)SNa: 385.1174, found: 385.1173.

(S)-2-methyl-N-((S)-2,2,2-trifluoro-1-((S)-5-methoxy-1-methyl-2-oxoindolin-3-yl)ethyl)propane-2-sulfinamide (7h)
White solid (176.4 mg, 93%), mp 174-179 °C, \([\alpha]_D^{25} = -1.35\ (c = 1.04, \text{CHCl}_3)\). (major isomer) \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 6.99 (s, 1H), 6.91 (dd, \(J = 8.5\), 2.3 Hz, 1H), 6.80 (d, \(J = 8.5\) Hz, 1H), 4.65-4.49 (m, 1H), 3.81 (s, 1H), 3.80 (s, 3H), 3.51 (d, \(J = 11.0\) Hz, 1H), 3.16 (s, 3H), 0.99 (s, 9H). \(^{19}\)F NMR (376 MHz, CDCl\(_3\)) \(\delta\) -71.64. \(^{13}\)C NMR (101 MHz, CDCl\(_3\)) \(\delta\) 173.6, 156.2, 138.6, 124.9 (q, \(J_{FC} = 283.5\) Hz), 123.0, 113.8, 113.2, 108.9, 59.0 (q, \(2J_{FC} = 31.3\)Hz), 57.2, 55.8, 46.8, 26.522.1. IR (cm\(^{-1}\)): \(\nu\) 3474, 3253, 2971, 2933, 2873, 2847, 1703, 1601, 1498, 1459, 1440, 1428, 1371, 1292, 1247, 1206, 1171, 1158, 1119, 1078, 1029, 939, 865, 819, 789, 757, 675, 667, 592, 566, 545. HRMS(ESI): [M+Na\(^+\)] calcd for C\(_{16}\)H\(_{21}\)F\(_3\)N\(_2\)O\(_3\)SNa: 401.1123, found: 401.1122.

(S)-2-methyl-N-((S)-2,2,2-trifluoro-1-((S)-6-fluoro-1-methyl-2-oxoindolin-3-yl)ethyl)propane-2-sulfinamide (7i)
White solid (164.7 mg, 90%), mp 153-158 °C, \([\alpha]_D^{25} = -50.5\ (c = 1.12, \text{CHCl}_3)\).
(major isomer) $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.32 (m, 1H), 6.80 (td, $J = 9.2, 2.3$ Hz, 1H), 6.64 (dd, $J = 8.6, 2.3$ Hz, 1H), 4.56 (dqd, $J = 10.4, 8.1, 2.2$ Hz, 1H), 3.83 (s, 1H), 3.47 (d, $J = 11.0, 1$H), 3.18 (s, 3H), 0.99 (s, 9H). $^{19}$F NMR (376 MHz, CDCl$_3$) $\delta$ -71.75, -109.80. $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 174.4, 163.8 (d, $J_{CF} = 247.9$ Hz), 146.9 (d, $J = 11.4$ Hz), 127.0, 124.8 (q, $J_{FC} = 283.4$ Hz), 117.1 (d, $J = 3.2$ Hz), 109.3 (d, $J = 22.3$ Hz), 97.5 (d, $J = 3.2$ Hz), 59.0 (q, $J_{FC} = 31.2$ Hz), 57.2, 46.0, 26.6, 22.1. IR (cm$^{-1}$): $\nu$ 3250, 2983, 2927, 2870, 1715, 1621, 1505, 1468, 1384, 1337, 1283, 1249, 1209, 1173, 1138, 1114, 1081, 1062, 966, 836, 761, 658, 580, 548. HRMS (ESI): [M+Na$^+$] calcd for C$_{15}$H$_{18}$F$_{3}$N$_{2}$O$_{2}$SNa: 389.0923, found: 389.0923.

(S)-N-((S)-1-((S)-6-chloro-1-methyl-2-oxoindolin-3-yl)-2,2,2-trifluoroethyl)-2-methylpropane-2-sulfinamide (7j)

White solid (186.2 mg, 97%), mp 176-179$^\circ$C, $[\alpha]_{D}^{25}$ = -45.6 ($c = 1.02$, CHCl$_3$). (major isomer) $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.29 (d, $J = 8.0$ Hz, 1H), 7.10(d, $J = 8.0, 1.8$ Hz, 1H), 6.89 (d, $J = 1.8$ Hz, 1H), 4.57 (dqd, $J = 10.5, 8.1, 2.3$ Hz, 1H), 3.83 (s, 1H), 3.52 (d, $J = 10.9$ Hz, 1H), 3.18 (s, 3H), 1.00 (s, 9H). $^{19}$F NMR (376 MHz, CDCl$_3$) $\delta$ -71.59. $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 174.0, 146.4, 135.6, 126.6, 124.7 (q, $J_{FC} = 283.4$ Hz), 122.9, 120.5, 109.4, 58.9 (q, $J_{FC} = 31.3$ Hz), 57.2, 46.1, 26.6, 22.1. IR (cm$^{-1}$): $\nu$ 3407, 3248, 2969, 2935, 2871, 1712, 1613, 1498, 1471, 1435, 1377, 1341, 1270, 1242, 1205, 1190, 1162, 1137, 1112, 1079, 947, 804, 653, 523. HRMS (ESI): [M+Na$^+$] calcd for C$_{15}$H$_{18}$ClF$_{3}$N$_{2}$O$_{2}$SNa: 405.0627, found: 405.0625.

(S)-N-((S)-1-((S)-1,6-dimethyl-2-oxoindolin-3-yl)-2,2,2-trifluoroethyl)-2-methylpropane-2-sulfinamide (7k)

Light yellow solid (164.8 mg, 91%), mp 153-157$^\circ$C, $[\alpha]_{D}^{25}$ = -50.5 ($c = 1.07$, CHCl$_3$). (major isomer) $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.24 (d, $J = 7.6$ Hz, 1H), 6.92 (d, $J = 7.6, 1$H), 6.70 (s, 1H), 4.54 (dqd, $J = 10.4, 8.1, 2.1$ Hz, 1H), 3.80 (s, 1H), 3.44 (d, $J = 11.1$ Hz, 1H), 3.17 (s, 3H), 2.40 (d, $J = 6.8$ Hz, 3H), 0.99 (s, 9H). $^{19}$F NMR (376 MHz, CDCl$_3$) $\delta$ -71.89. $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 174.0, 145.3, 140.1, 125.4 (q, $J = 3.4$ Hz), 124.9 (q, $J_{FC} = 283.4$ Hz), 123.7, 118.6, 109.5, 59.1 (q, $J_{FC} = 31.3$ Hz), 57.1, 46.2, 26.4, 22.1, 21.8. IR (cm$^{-1}$): $\nu$ 3246, 3062, 2925, 2870, 1709, 1621, 1459, 1384, 1340, 1247, 11
72, 1116, 1083, 993, 812, 658, 571. HRMS (ESI): [M+Na\(^+\)] calcd for C\(_{16}\)H\(_{21}\)F\(_3\)N\(_2\)O\(_2\)SNa: 385.1174, found: 385.1172

(S)-N-((S)-1-((S)-7-chloro-1-methyl-2-oxoindolin-3-yl)-2,2,2-trifluoroethyl)-2-methylpropane-2-sulfinamide (7l)
White solid (170.3 mg, 89%), mp 140-144 \(^\circ\)C, \([\alpha]_D\) = -82.1 (c = 1.02, CHCl\(_3\)).
(major isomer) \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.29 (dd, \(J = 19.2, 7.6\) Hz, 2 H), 7.03 (t, \(J = 7.7\) Hz, 1H), 4.62-4.54 (m, 1H), 3.86 (s, 1H), 3.60 (s, 1H), 3.57 (s, 3H), 1.03 (s, 9H).
\(^{19}\)F NMR (376 MHz, CDCl\(_3\)) \(\delta\) -71.30.
\(^{13}\)C NMR (101 MHz, CDCl\(_3\)) \(\delta\) 174.4, 141.0, 132.0, 124.7 (q, \(J_{FC} = 283.4\) Hz), 124.7 (s), 124.0 (q, \(J = 3.4\) Hz), 123.8, 116.1, 59.0 (q, \(2J_{FC} = 31.3\) Hz), 57.3, 46.3, 30.1, 22.1. IR (cm\(^{-1}\)): \(\nu\) 3264, 2983, 2904, 1705, 1608, 1583, 1465, 1370, 1342, 1248, 1193, 1135, 1080, 1053, 1004, 940, 798, 732, 528. HRMS (ESI): [M+Na\(^+\)] calcd for C\(_{15}\)H\(_{18}\)ClF\(_3\)N\(_2\)O\(_2\)SNa: 405.0627, found: 405.0627.

(S)-2-methyl-N-((S)-2,2,2-trifluoro-1-((S)-1-methyl-2-oxo-7-(trifluoromethyl)indolin-3-yl)ethyl)propane-2-sulfinamide (7m)
Light yellow solid (174.8 mg, 84%), mp 169-173 \(^\circ\)C, \([\alpha]_D\) = -43.7 (c = 0.64, CHCl\(_3\)).
(major isomer) \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.69 (d, \(J = 8.2\) Hz, 1H), 7.56 (d, \(J = 7.5\) Hz, 1H), 7.21 (t, \(J = 7.8\) Hz, 1H), 4.61 (dq, \(J = 10.5, 8.1, 2.3\) Hz, 1H), 3.88 (s, 1H), 3.55 (s, 1H), 3.41 (dd, \(J = 4.5, 2.2\) Hz, 3H), 1.00 (s, 9H).
\(^{19}\)F NMR (376 MHz, CDCl\(_3\)) \(\delta\) -53.20, -71.17.
\(^{13}\)C NMR (101 MHz, CDCl\(_3\)) \(\delta\) 175.0, 143.0, 128.9 (d, \(J = 2.9\) Hz), 127.5 (q, \(J = 8.1\) Hz), 124.6 (q, \(J_{FC} = 283.4\) Hz), 124.5, 122.4, 123.28 (q, \(J = 271.5\) Hz), 113.1 (q, \(J = 33.2\) Hz), 59.2 (q, \(J = 31.5\) Hz), 57.3, 45.1, 29.2 (q, \(J = 6.6\) Hz), 22.0. IR (cm\(^{-1}\)): \(\nu\) 3267, 2967, 2924, 2854, 1713, 1600, 1600, 1488, 1459, 1419, 1391, 1357, 1341, 1318, 1263, 1180, 1111, 1084, 1004, 946, 811, 787, 749, 663, 600, 502. HRMS (ESI): [M+Na\(^+\)] calcd for C\(_{16}\)H\(_{19}\)F\(_6\)N\(_2\)O\(_2\)SNa: 439.0891, found: 439.0891.
4. Reaction of large scale application study

Into an oven-dried round-bottom flask flushed with N₂ were taken compound 6l (745 mg, 4.10 mmol) and anhydrous DCM (20.0 mL). The reaction flask was cooled to -78 °C and LDA (2 M in Hexene, 4.11 mL) was added dropwise with stirring. After 3 h at -78 °C, sulfinylimine 1 (690 mg, 3.43 mmol) dissolved in anhydrous DCM (10.0 mL) was added dropwise. Stirring was continued at -78 °C for 12 h, then the reaction was quenched with saturated NH₄Cl (10.0 mL), followed by H₂O (10.0 mL) and the mixture was brought to room temperature. The organic layer was taken and the aqueous layer was extracted with EtOAc (2 × 30 mL). The combined organic layers were dried with anhydrous Na₂SO₄, filtered and the solvent was removed to give the crude product, which was purified by column chromatography (hexane/EtOAc, 2:1).

\[ \text{1) LDA, -78 °C, 12h} \]
\[ \text{2) aq NH₄Cl} \]

5. X-ray crystallography for 5a

![ORTEP diagram showing compound 5a (ccdc number 1007432).](image-url)
6. $^{19}$F-NMR spectra of crude reaction mixture for optimization of the reaction conditions (Table 1, 2)

$^{19}$F-NMR spectra of crude reaction mixture for Entry 3 of Table 1

$^{19}$F-NMR spectra of crude reaction mixture for Entry 4 of Table 1
$^{19}$F-NMR spectra of crude reaction mixture for Entry 5 of Table 1

$^{19}$F-NMR spectra of crude reaction mixture for Entry 6 of Table 1
$^{19}$F-NMR spectra of crude reaction mixture for Entry 7 of Table 1

Table 1
Entry 7
Solvent: THF
Base: BuOK

$^{19}$F-NMR spectra of crude reaction mixture for Entry 8 of Table 1

Table 1
Entry 8
Solvent: THF
Base: LiHMDS
\(^{19}\)F-NMR spectra of crude reaction mixture for Entry 9 of Table 1

Table 1
Entry 9
Solvent: THF
Base: LiNMe₂

\(^{19}\)F-NMR spectra of crude reaction mixture for Entry 10 of Table 1

Table 1
Entry 10
Solvent: THF
Base: NaHAl₃
$^{19}$F-NMR spectra of crude reaction mixture for Entry 1 of Table 2

$^{19}$F-NMR spectra of crude reaction mixture for Entry 2 of Table 2
$^{19}$F-NMR spectra of crude reaction mixture for Entry 3 of Table 2

$^{19}$F-NMR spectra of crude reaction mixture for Entry 4 of Table 2
$^{19}$F-NMR spectra of crude reaction mixture for Entry 5 of Table 2

Table 2:
Entry 5
Solvent: CH$_2$CN
Base: LDA

$^{19}$F-NMR spectra of crude reaction mixture for Entry 6 of Table 2

Table 2:
Entry 6
Solvent: DCM
Base: LDA
Time: 9 hrs
$^{19}$F-NMR spectra of crude reaction mixture for Entry 7 of Table 2

7.$^1$H and $^{13}$C NMR spectra for compounds 5 and 7

$^1$H NMR and $^{13}$C NMR spectrum of 5a
$^1$H NMR and $^{13}$C NMR spectrum of 5b
$^1$H NMR and $^{13}$C NMR spectrum of 5c
$^1$H NMR and $^{13}$C NMR spectrum of 5d
$^1$H NMR and $^{13}$C NMR spectrum of 5e
$^1$H NMR and $^{13}$C NMR spectrum of 7a
$^1$H NMR and $^{13}$C NMR spectrum of 7b
$^1$H NMR and $^{13}$C NMR spectrum of 7c
$^1$H NMR and $^{13}$C NMR spectrum of 7d
$^1$H NMR and $^{13}$C NMR spectrum of 7e
$^1$H NMR and $^{13}$C NMR spectrum of 7f
$^1$H NMR and $^{13}$C NMR spectrum of 7g
$^1$H NMR and $^{13}$C NMR spectrum of 7h
$^1$H NMR and $^{13}$C NMR spectrum of 71
$^1$H NMR and $^{13}$C NMR spectrum of 7m