Supplementary Information for

Synthesis of Chiral Sulfones via Nickel-Catalyzed Asymmetric Hydrogenation

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1. Experimental Section

**General Information:** All the air or moisture sensitive reactions and manipulations were performed by using standard Schlenk techniques and in a nitrogen-filled glovebox. THF, dioxane and toluene were distilled from sodium benzophenone ketyl. DCM and DCE was distilled from calcium hydride. Anhydrous MeOH was distilled from magnesium. $^1$H NMR and $^{13}$C NMR spectra were recorded on Bruker AV (400 MHz) spectrometers and JEOL JNM-ECX600P and JNM-ECS600 (400 MHz or 600 MHz) spectrometers. (CDC$_3$ was the solvent used for the NMR analysis, with TMS as the internal standard). Optical rotation was determined using Autopol III Automatic polarimeter (Rudolph research Analytical). HPLC analysis was conducted on Agilent 1260 series instrument. SFC analysis was conducted on Agilent 1260 series instrument. HRMS were recorded on a Waters LCT Premier XE mass spectrometer with TOF.

2. General procedure for the synthesis of substrates

**General Procedure 1**

$$\begin{align*}
\text{R} & \rightarrow \text{O} \\
\text{R'} & \rightarrow \text{S} \\
\text{1. n-BuLi/THF} & \\
\text{2.DMAP/Et}_3\text{N/TFAA/CH}_2\text{Cl}_2 & \\
\end{align*}$$

Methyl phenyl sulfon (1.00 eq.) was placed in an oven-dried 250 mL, three-neck round bottom flask. THF (6 mL/mmol) was added under nitrogen. The reaction mixture was cooled and n-BuLi (1.10 eq.) was added dropwise with stirring at -78 °C. The solution was stirred for 30 min at -78 °C. And then, the corresponding ketones (1.10 eq.) were added to the solution dropwise, maintained -78 °C. The solution was stirred for 1 h until no starting material was detected by TLC. The reaction mixture was quenched with saturated aqueous NH$_4$Cl solution and extracted with ethyl acetate. The combined organic layers were washed with brine, dried over Na$_2$SO$_4$, and concentrated. The crude product and DMAP (0.10 eq.) was dissolved in DCM (30 mL), the reaction mixture was cooled, Et$_3$N (2.00 eq.) and TFAA (1.20 eq.) was added with stirring at 0 °C, then the reaction mixture was rise to room temperature after 30 min and stirred overnight. The reaction mixture was quenched with saturated aqueous NH$_4$Cl solution and
extracted with DCM. The combined organic layers were washed with brine, dried over Na₂SO₄, and concentrated. The residue was purification by chromatography on silica gel gave 1 and 3m.

**General Procedure 2¹**

Phenylacetylene (1.00 eq.) was placed in an oven-dried 250 mL three-neck round bottom flask. THF (4 mL/mmol) was added under nitrogen. The reaction mixture was cooled and n-BuLi (1.10 eq.) was added dropwise with stirring at 0 °C. The solution was stirred at 0 °C for 1.5 h. And then, 1,2-diphenyldisulfane (1.00 eq.) was added to the solution in one portion, maintained 0 °C for 2 h. Then the solution was stirred at room temperature for 2 d. The reaction mixture was quenched with distilled water and extracted with ethyl acetate. The combined organic layers were washed three times with aqueous NaOH (0.1 M), and brine, dried over Na₂SO₄, and concentrated. The residue was purification by flash chromatography gave phenyl(phenylethynyl)sulfane. To a mixture of phenyl(phenylethynyl)sulfane (1.00 eq.) in DCM (20 mL/mmol) was added mCPBA (1.00 eq.) at 0 °C and the reaction mixture was stirred at 0°C for 2 h. The solution was quenched with 30% aqueous Na₂SO₃ and extracted with CH₂Cl₂, then
washed with saturated aqueous NaHCO₃ and brine, and dried over Na₂SO₄, concentrated in vacuo to give crude product ((phenylethynyl)sulfinyl)benzene. CuX (1.28 eq.) was added to an oven-dried 250 mL three-neck round bottom flask under nitrogen, THF (4 mL/mmol) was added and the reaction mixture was cooled to -20 °C. Then LiBr (CuX = CuBr, 1.28 eq.) in THF (0.8 mL/mmol) was added, followed by stirring for 10 min. The RLi (1.25 eq., CuI used) or RMgX (1.25 eq.) (CuBr/LiBr used) was added dropwise at -20 °C, followed by stirring for 15 min. After that, the solution was cooled to -78 °C and a solution of crude product ((phenylethynyl)sulfinyl)benzene (1.00 eq.) in THF (4 mL/mmol) was added dropwise and stirred at -78 °C for 1 h. The reaction was quenched with MeOH, and a saturated solution of NH₄Cl was added, then extracted three times with DCM. The combined organic extracts were washed with water, brine and then dried over Na₂SO₄, concentrated in vacuo to give crude product sulfoxide without purification.

The crude product sulfoxide (1.00 eq.) was suspended in glacial AcOH (1.11mL/mmol) then, 30% H₂O₂ (6.50 eq.) was slowly added. The mixture was heated to 100 °C and stirred for 1 h. The reaction mixture was cooled to room temperature, then saturated aqueous NaHCO₃ (bring the pH ≈ 7) was added, and extracted with DCM. The organic extracts were washed with brine and dried over Na₂SO₄ and concentrated in vacuo. The residue was purified by chromatography gave 3.

The crude product sulfoxide (1.00 eq.) was dissolved in DCM (20 mL/mmol), mCPBA was added (1.00 eq.) at 0 °C and the reaction mixture was stirred at 0°C for 2 h. The solution was quenched with 30% aqueous Na₂SO₃ and extracted with CH₂Cl₂, then washed with saturated aqueous NaHCO₃ and brine, and dried over Na₂SO₄, concentrated in vacuo. The residue was purified by chromatography gave 1q.

**General Procedure 3**

Add I₂ (1.5 eq.) to a suspension mixture of styrene derivative (3.0 mmol), Sodium
methanesulfinate (3 eq.) and NaOAc (1.5 eq.) in MeCN (15 mL). Stir the reaction mixture at refluxing temperature for 2 hours. Quench the reaction mixture by the addition of saturated aqueous sodium thiosulfate. Basify the mixture with saturated aqueous sodium hydrogen carbonate. Stir the mixture by extraction with ethyl acetate. Wash the combined organic extracts with water, brine. The organic extracts were washed with brine and dried over Na₂SO₄ and concentrated in vacuo. The residue was purified by chromatography gave 3n.

3. NMR and HRMS data of substrates

(E)-1-fluoro-3-(1-(phenylsulfonyl)prop-1-en-2-yl)benzene (1a)

Purification by column chromatography (silica gel, PE:EA = 10:1, 5 × 20 cm) afforded the product as white solid; 1.60 g, yield: 58%; ¹H NMR (600 MHz, Chloroform-d) δ 8.00-7.95 (m, 2H), 7.66-7.62 (m, 1H), 7.59-7.55 (m, 2H), 7.35-7.31 (m, 1H), 7.19-7.16 (m, 1H), 7.10-7.06 (m, 2H), 6.63-6.58 (m, 1H), 2.53 (d, J = 1.2 Hz, 3H). MP: 49-51 °C (from ethyl acetate-hexane). The analytical data are consistent with the literature.

(E)-1-fluoro-2-(1-(phenylsulfonyl)prop-1-en-2-yl)benzene (1b)

Purification by column chromatography (silica gel, PE:EA = 10:1, 5 × 20 cm) afforded the product as white solid; 1.61 g, yield: 61%; ¹H NMR (600 MHz, Chloroform-d) δ 8.01-7.96 (m, 2H), 7.66-7.62 (m, 1H), 7.59-7.55 (m, 2H), 7.35-7.30 (m, 1H), 7.25-7.21 (m, 1H), 7.15-7.11 (m, 1H), 7.08-7.04 (m, 1H), 6.55-6.51 (m, 1H), 2.51 (t, J = 1.4 Hz, 3H). MP: 65-68 °C (from ethyl acetate-hexane). The analytical data are consistent with the literature.

(E)-1-fluoro-4-(1-(phenylsulfonyl)prop-1-en-2-yl)benzene (1c)

Purification by column chromatography (silica gel, PE:EA = 10:1, 5 × 20 cm) afforded the product as white solid; 1.98 g, yield: 72%; ¹H NMR (400 MHz, Chloroform-d) δ 8.01-7.94 (m, 2H), 7.66-7.60 (m, 1H), 7.59-7.54 (m, 2H), 7.41-7.36 (m, 2H), 7.08-7.02 (m, 2H), 6.57 (s, 1H), 2.52 (d, J = 1.2 Hz, 3H). MP: 54-56 °C (from ethyl acetate-hexane). The analytical data are consistent with the literature.
(E)-1-chloro-3-(1-(phenylsulfonyl)prop-1-en-2-yl)benzene (1d)

Purification by column chromatography (silica gel, PE:EA = 10:1, 5 × 20 cm) afforded the product as white solid; 1.54 g, yield: 53%; 1H NMR (400 MHz, Chloroform-d) δ 8.02-7.93 (m, 2H), 7.67-7.61 (m, 1H), 7.60-7.55 (m, 2H), 7.37-7.26 (m, 4H), 6.59 (q, J = 1.2 Hz, 1H), 2.52 (d, J = 1.3 Hz, 3H). MP: 68-70 °C (from ethyl acetate-hexane). The analytical data are consistent with the literature.1

(E)-1-chloro-4-(1-(phenylsulfonyl)prop-1-en-2-yl)benzene (1e)

Purification by column chromatography (silica gel, PE:EA = 10:1, 5 × 20 cm) afforded the product as white solid; 1.25 g, yield: 43%; 1H NMR (400 MHz, Chloroform-d) δ 7.99-7.95 (m, 2H), 7.66-7.61 (m, 1H), 7.56 (t, J = 7.5 Hz, 2H), 7.36-7.31 (m, 4H), 6.58 (d, J = 1.2 Hz, 1H), 2.51 (d, J = 0.9 Hz, 3H). MP: 99-101 °C (from ethyl acetate-hexane). The analytical data are consistent with the literature.3

(E)-1-bromo-3-(1-(phenylsulfonyl)prop-1-en-2-yl)benzene (1f)

Purification by column chromatography (silica gel, PE:EA = 10:1, 5 × 20 cm) afforded the product as white solid; 1.74 g, yield: 52%; 1H NMR (400 MHz, Chloroform-d) δ 8.00-7.95 (m, 2H), 7.67-7.62 (m, 1H), 7.60-7.55 (m, 2H), 7.52-7.48 (m, 2H), 7.33-7.29 (m, 1H), 7.26-7.20 (m, 1H), 6.61-6.54 (m, 1H), 2.52 (d, J = 1.3 Hz, 3H). MP: 80-82 °C. (from ethyl acetate-hexane). The analytical data are consistent with the literature.1

(E)-1-bromo-4-(1-(phenylsulfonyl)prop-1-en-2-yl)benzene (1g)

Purification by column chromatography (silica gel, PE:EA = 10:1, 5 × 20 cm) afforded the product as white solid; 1.47 g, yield: 44%; 1H NMR (600 MHz, Chloroform-d) δ 8.00-7.93 (m, 2H), 7.64-7.60 (m, 1H), 7.58-7.53 (m, 2H), 7.50-7.44 (m, 2H), 7.27-7.22 (m, 2H), 6.60-6.55 (m, 1H), 2.50 (d, J = 1.1 Hz, 3H). 13C NMR (100 MHz, Chloroform-d) δ = 152.0, 141.8, 138.9, 133.3, 131.8, 129.2, 127.8, 127.8 127.2, 124.2, 17.0; MP: 113-115 °C (from ethyl acetate-hexane). TOF-HRMS Calculated for C15H14O2BrS ([M+H]+):
336.9892, found 336.9896, 338.9876.

(E)-1-methoxy-2-(1-phenylsulfonyl)prop-1-en-2-yl)benzene (1h)

Purification by column chromatography (silica gel, PE:EA = 10:1, 5 × 20 cm) afforded the product as colorless solid; 1.76 g, yield: 45%; 1H NMR (600 MHz, Chloroform-d) δ 8.00-7.97 (m, 2H), 7.63-7.61 (m, 1H) 7.56 (t, J = 7.6 Hz, 2H), 7.32-7.28 (m, 1H), 7.08 (dd, J = 7.5, 1.7 Hz, 1H), 6.92-6.89 (m, 1H), 6.87 (d, J = 8.3 Hz, 1H), 6.45-6.42 (m, 1H), 3.77 (s, 3H), 2.46 (d, J = 1.3 Hz, 3H). MP: 69-71 °C (from ethyl acetate-hexane). The analytical data are consistent with the literature.1

(E)-1-methoxy-3-(1-phenylsulfonyl)prop-1-en-2-yl)benzene (1i)

Purification by column chromatography (silica gel, PE:EA = 10:1, 5 × 20 cm) afforded the product as white solid; 1.64 g, yield: 64%; 1H NMR (600 MHz, Chloroform-d) δ 7.97 (d, J = 7.8 Hz, 2H), 7.62 (t, J = 7.5 Hz, 1H), 7.56 (t, J = 7.7 Hz, 2H), 7.29-7.26 (m, 1H), 6.99-6.96 (m, 1H), 6.93-6.89 (m, 2H), 6.61 (s, 1H), 3.81 (s, 3H), 2.52 (s, 3H). MP: 65-67 °C (from ethyl acetate-hexane). The analytical data are consistent with the literature.4

(E)-1-methyl-4-(1-phenylsulfonyl)prop-1-en-2-yl)benzene (1j)

Purification by column chromatography (silica gel, PE:EA = 10:1, 5 × 20 cm) afforded the product as white solid; 1.27 g, yield: 47%; 1H NMR (600 MHz, Chloroform-d) δ 8.00-7.95 (m, 2H), 7.61 (t, J = 7.4 Hz, 1H), 7.55 (t, J = 7.6 Hz, 2H), 7.30 (d, J = 8.2 Hz, 2H), 7.17 (d, J = 8.0 Hz, 2H), 6.63-6.58 (m, 1H), 2.53-2.50 (m, 3H), 2.35 (s, 3H). MP: 70-72°C; The analytical data are consistent with the literature.4

(E)-1-methyl-2-(1-phenylsulfonyl)prop-1-en-2-yl)benzene (1k)

Purification by column chromatography (silica gel, PE:EA = 10:1, 5 × 20 cm) afforded the product as light yellow liquid; 1.76 g, yield: 65%; 1H NMR (600 MHz, Chloroform-d) δ 7.98-7.96 (m, 2H), 7.63 (t, J = 7.0 Hz, 1H), 7.56 (t, J = 7.6 Hz, 2H), 7.21-7.18 (m, 1H), 7.16-7.12 (m,
2H), 6.99 (d, J = 7.8 Hz, 1H), 6.28-6.23 (m, 1H), 2.42 (d, J = 1.3 Hz, 3H), 2.17 (s, 3H). The analytical data are consistent with the literature.\(^1\)

\((E)-((2\text{-phenylprop}-1\text{-en}-1\text{-yl})\text{sulfonyl})\text{benzene (11)}\)

\[
\text{SO}_2\text{Ph}
\]

Purification by column chromatography (silica gel, PE:EA = 10:1, 5 × 20 cm) and recrystallization afforded the product as white solid; 1.75 g, yield: 68%; \(^1\)H NMR (400 MHz, Chloroform-\(d\)) \(\delta\) 8.01-7.95 (m, 2H), 7.65-7.60 (m, 1H), 7.59-7.54 (m, 2H), 7.41-7.35 (m, 5H), 6.61 (q, J = 1.2 Hz, 1H), 2.55-2.51 (m, 3H). MP: 81-83 °C (from ethyl acetate-hexane). The analytical data are consistent with the literature.\(^3\)

\((E)-((2\text{-phenylbut}-1\text{-en}-1\text{-yl})\text{sulfonyl})\text{benzene (1m)}\)

\[
\text{SO}_2\text{Ph}
\]

Purification by column chromatography (silica gel, PE:EA = 10:1, 5 × 20 cm) afforded the product as light yellow liquid; 0.87 g, yield: 32%; \(^1\)H NMR (600 MHz, Chloroform-\(d\)) \(\delta\) 8.00-7.97 (m, 2H), 7.64-7.61 (m, 1H), 7.57-7.54 (m, 2H), 7.38-7.34 (m, 5H), 6.48 (s, 1H), 3.07 (q, J = 7.5 Hz, 2H), 0.97 (t, J = 7.5 Hz, 3H). The analytical data are consistent with the literature.\(^1\)

\((E)-(1\text{-cyclohexyl}-2\text{-}(phenylsulfonyl)vinyl)\text{benzene (1n)}\)

\[
\text{SO}_2\text{Ph}
\]

Purification by column chromatography (silica gel, PE:EA = 10:1, 5 × 20 cm) afforded the product as white solid; 1.50 g, yield: 46%; \(^1\)H NMR (400 MHz, Chloroform-\(d\)) \(\delta\) 7.46-7.41 (m, 3H), 7.31-7.24 (m, 3H), 7.22-7.18 (m, 2H), 6.90-6.87 (m, 2H), 6.48 (d, J = 1.2 Hz, 1H), 2.20-2.09 (m, 1H), 1.77-1.70 (m, 4H), 1.65-1.60 (m, 1H), 1.21-1.06 (m, 5H). \(^13\)C NMR (150 MHz, Chloroform-\(d\)) \(\delta\) 163.5, 141.8, 136.4, 132.7, 128.6, 128.4, 128.0, 127.7, 127.6, 47.9, 31.3, 26.3, 25.9. MP: 81-83 °C (from ethyl acetate-hexane). TOF-HRMS Calculated for C\(_{20}\)H\(_{23}\)O\(_2\)S ([M+H]\(^+\)): 327.1413, found 327.1417.

\((E)-1\text{-}(1\text{-}(phenylsulfonyl)prop}-1\text{-en}-2\text{-yl})\text{naphthalene (1o)}\)

\[
\text{SO}_2\text{Ph}
\]

Purification by column chromatography (silica gel, PE:EA = 10:1, 5 × 20 cm) afforded the product as colorless solid; 2.09 g, yield: 68%; \(^1\)H NMR (400 MHz, Chloroform-\(d\)) \(\delta\) 8.07-8.01 (m,
2H), 7.87-7.79 (m, 2H), 7.71-7.65 (m, 2H), 7.61 (t, $J = 7.4$ Hz, 2H), 7.52-7.45 (m, 2H), 7.42 (t, $J = 7.7$ Hz, 1H), 7.23 (d, $J = 7.0$ Hz, 1H), 6.56-6.43 (m, 1H), 2.62 (d, $J = 1.2$ Hz, 3H). MP: 74-76 °C (from ethyl acetate-hexane). The analytical data are consistent with the literature.  

$(E)$-2-(1-(phenylsulfanyl)prop-1-en-2-yl)naphthalene (1p)

Purification by column chromatography (silica gel, PE:EA = 10:1, 5 × 20 cm) afforded the product as colorless solid; 2.20 g, yield: 72%; $^1$H NMR (400 MHz, Chloroform-d) $\delta$ 8.03-7.98 (m, 2H), 7.87 (d, $J = 1.5$ Hz, 1H), 7.84-7.80 (m, 3H), 7.65-7.61 (m, 1H), 7.59-7.54 (m, 2H), 7.52-7.46 (m, 3H), 6.75 (d, $J = 1.2$ Hz, 1H), 2.63 (d, $J = 1.2$ Hz, 3H). MP: 120-122 °C (from ethyl acetate-hexane). The analytical data are consistent with the literature.

$(Z)$-((2-phenylbut-1-en-1-yl)sulfonyl)benzene (1q)

Purification by column chromatography (silica gel, PE:EA = 10:1, 5 × 20 cm) afforded the product as light yellow liquid; 1.30 g, yield: 48% (three steps); $^1$H NMR (600 MHz, Chloroform-d) $\delta$ 7.46 (dd, $J = 21.5$, 7.8 Hz, 3H), 7.33-7.27 (m, 3H), 7.26-7.21 (m, 2H), 6.98 (d, $J = 7.2$ Hz, 2H), 6.51 (s, 1H), 2.39 (q, $J = 7.3$ Hz, 2H), 1.01 (t, $J = 7.3$ Hz, 3H). The analytical data are consistent with the literature.

$(E)$-1-fluoro-4-((2-phenylprop-1-en-1-yl)sulfonyl)benzene (1r)

Purification by column chromatography (silica gel, PE:EA = 10:1, 5 × 20 cm) afforded the product as light yellow liquid; 1.35 g, yield: 49%; $^1$H NMR (600 MHz, Chloroform-d) $\delta$ 8.01-7.97 (m, 2H), 7.40-7.35 (m, 5H), 7.25-7.21 (m, 2H), 6.60-6.57 (m, 1H), 2.54 (d, $J = 1.1$ Hz, 3H). $^{13}$C NMR (150 MHz, Chloroform-d) $\delta$ = 165.5 (d, $J = 256.7$ Hz), 153.7, 140.0, 138.3, 130.1, 130.0, 128.8, 127.3, 126.3, 116.5, 17.2. TOF-HRMS Calculated for C$_{15}$H$_{14}$O$_2$FS ([M+H]$^+$): 277.0693, found 277.0699.

$(E)$-1-chloro-4-((2-phenylprop-1-en-1-yl)sulfonyl)benzene (1s)
Purification by column chromatography (silica gel, PE:EA = 10:1, 5 × 22 cm) afforded the product as white solid; 1.52 g, yield: 52%; \(^1\)H NMR (600 MHz, Chloroform-\(d\)) \(\delta = 7.91\) (d, \(J = 8.4\) Hz, 2H), 7.53 (d, \(J = 8.4\) Hz, 2H), 7.42-7.34 (m, 5H), 6.58 (s, 1H), 2.53 (s, 3H); MP: 79-81 °C (from ethyl acetate-hexane). The analytical data are consistent with the literature.\(^5\)

\((E)-3-(1-(phenylsulfonyl)prop-1-en-2-yl)pyridine (1t)\)

Purification by column chromatography (silica gel, PE:EA = 1:1, 5 × 20 cm) afforded the product as white solid; 0.99 g, yield: 38%; \(^1\)H NMR (600 MHz, Chloroform-\(d\)) \(\delta = 8.63-8.62\) (m, 1H), 8.60-8.59 (m, 1H), 7.97 (dt, \(J = 7.3, 1.4\) Hz, 2H), 7.68 (ddd, \(J = 8.1, 2.5, 1.5\) Hz, 1H), 7.65-7.62 (m, 1H), 7.58-7.55 (m, 2H), 7.31-7.28 (m, 1H), 6.61 (d, \(J = 1.3\) Hz, 1H), 2.55 (d, \(J = 1.4\) Hz, 3H). \(^1^3\)C NMR (151 MHz, Chloroform-\(d\)) \(\delta = 150.8, 150.0, 147.3, 141.6, 135.8, 133.6, 133.5, 129.3, 128.9, 127.3, 123.4, 17.0\). MP: 96-97 °C (from ethyl acetate-hexane). TOF-HRMS Calculated for C\(_{14}\)H\(_{14}\)NO\(_2\)S ([M+H]\(^+\)): 260.0740, found 260.0742.

\((E)-1\)-(fluoro-3-(1-phenyl-2-(phenylsulfonyl)vinyl)benzene (3a)\)

Purification by column chromatography (silica gel, PE:EA = 10:1, 5 × 20 cm) and recrystallization afforded the product as white solid; 0.95 g, yield: 28% (three steps); \(^1\)H NMR (400 MHz, Chloroform-\(d\)) \(\delta = 7.59-7.54\) (m, 2H), 7.51-7.46 (m, 1H), 7.39-7.32 (m, 3H), 7.31-7.26 (m, 3H), 7.09-7.03 (m, 3H), 7.03-7.00 (m, 2H), 6.89-6.84 (m, 1H). MP: 109-111 °C. (from ethyl acetate-hexane). The analytical data are consistent with the literature.\(^1\)

\((Z)-1\)-(fluoro-3-(1-phenyl-2-(phenylsulfonyl)vinyl)benzene (3a)\)

Purification by column chromatography (silica gel, PE:EA = 10:1, 5 × 20 cm) and recrystallization afforded the product as white solid; 0.91 g, yield: 27% (three steps); \(^1\)H NMR (600 MHz, Chloroform-\(d\)) \(\delta = 7.63\) (dd, \(J = 8.4, 1.2\) Hz, 2H), 7.55-7.51 (m, 1H), 7.42-7.38 (m, 3H), 7.34-7.29 (m, 3H), 7.22-7.19 (m, 2H), 7.09-7.05 (m, 1H), 7.03 (s, 1H), 6.98-6.95 (m,
1H), 6.72-6.68 (m, 1H). MP: 81-83 °C (from ethyl acetate-hexane). The analytical data are consistent with the literature.\(^1\)

\((E)-1\)-fluoro-4-(1-phenyl-2-(phenylsulfonyl)vinyl)benzene (3b)

Purification by column chromatography (silica gel, PE:EA = 10:1, 5 × 22 cm) and recrystallization afforded the product as white solid; 1.08 g, yield: 32% (three steps); \(^1\)H NMR (600 MHz, Chloroform-\(d\)) \(\delta 7.57 (d, J = 7.9 \text{ Hz}, 2H), 7.49 (t, J = 7.4 \text{ Hz}, 1H), 7.39-7.33 (m, 3H), 7.29 (t, J = 7.6 \text{ Hz}, 2H), 7.20 (dd, J = 8.6, 5.4 \text{ Hz}, 2H), 7.06 (d, J = 7.5 \text{ Hz}, 2H), 7.02-6.96 (m, 3H). MP: 121-123 °C (from ethyl acetate-hexane). The analytical data are consistent with the literature.\(^1\)

\((E)-1\)-chloro-4-(1-phenyl-2-(phenylsulfonyl)vinyl)benzene (3c)

Purification by column chromatography (silica gel, PE:EA = 10:1, 5 × 20 cm) and recrystallization afforded the product as white solid; 1.09 g. Yield: 31% (three steps); \(^1\)H NMR (600 MHz, Chloroform-\(d\)) \(\delta 7.62-7.56 (m, 2H), 7.51-7.47 (m, 1H), 7.40-7.33 (m, 4H), 7.32-7.27 (m, 3H), 7.17-7.12 (m, 2H), 7.11-6.98 (m, 3H). MP: 96-98 °C (from ethyl acetate-hexane). The analytical data are consistent with the literature.\(^1\)

\((E)-1\)-methyl-2-(1-phenyl-2-(phenylsulfonyl)vinyl)benzene (3d)

Purification by column chromatography (silica gel, PE:EA = 10:1, 5 × 20 cm) and recrystallization afforded the product as white solid; 0.96 g, yield: 29% (three steps); \(^1\)H NMR (600 MHz, Chloroform-\(d\)) \(\delta 7.76-7.68 (m, 2H), 7.56-7.49 (m, 1H), 7.38 (t, J = 7.9 \text{ Hz}, 2H), 7.33-7.28 (m, 3H), 7.26-7.24 (m, 3H), 7.15 (dd, J = 14.7, 7.4 \text{ Hz}, 2H), 7.06 (d, J = 7.6 \text{ Hz}, 1H), 6.63 (d, J = 14.2 \text{ Hz}, 1H), 2.04 (s, 3H). MP: 111-113 °C (from ethyl acetate-hexane). The analytical data are consistent with the literature.\(^1\)

\((E)-1\)-methyl-3-(1-phenyl-2-(phenylsulfonyl)vinyl)benzene (3e)

Purification by column chromatography (silica gel, PE:EA = 10:1, 5 × 20 cm) and recrystallization afforded the product as yellow solid; 0.90 g, yield: 27% (three steps); \(^1\)H NMR (600 MHz,
Chloroform-\textit{d}) \( \delta 7.60-7.55 \) (m, 2H), 7.50-7.46 (m, 1H), 7.38-7.32 (m, 3H), 7.28 (d, \( J = 7.8 \) Hz, 2H), 7.20-7.17 (m, 2H), 7.09-7.05 (m, 2H), 7.04 (s, 1H), 7.01 (d, \( J = 1.9 \) Hz, 1H), 6.99-6.97 (m, 1H), 2.30 (s, 3H). MP: 119-121 °C (from ethyl acetate-hexane). The analytical data are consistent with the literature.¹

\textit{(E)-1-methyl-4-(1-phenyl-2-(phenylsulfonyl)vinyl)benzene (3f)}

\[
\text{Purification by column chromatography (silica gel, PE:EA = 10:1, 5 x 20 cm) and recrystallization afforded the product as white solid; 0.83 g, yield: 25\% (three steps); }^{1} \text{H NMR (600 MHz, Chloroform-\textit{d}) } \delta 7.58-7.55 \text{ (m, 2H), 7.47 (t, } J = 7.9 \text{ Hz, 1H), 7.40-7.31 \text{ (m, 5H), 7.29 (s, 2H), 7.10 (s, 4H), 7.07-7.04 \text{ (m, 2H), 7.00 (d, } J = 3.9 \text{ Hz, 1H), 2.34 \text{ (s, 3H). MP: 113-115 °C (from ethyl acetate-hexane). The analytical data are consistent with the literature.}}^{1}
\]

\textit{(E)-1,2-dichloro-4-(1-phenyl-2-(phenylsulfonyl)vinyl)benzene (3g)}

\[
\text{Purification by column chromatography (silica gel, PE:EA = 10:1, 5 x 20 cm) and recrystallization afforded the product as white solid; 1.47 g, yield: 38\% (three steps); }^{1} \text{H NMR (600 MHz, Chloroform-\textit{d}) } \delta 7.64 \text{ (d, } J = 8.1 \text{ Hz, 2H), 7.57 (t, } J = 7.4 \text{ Hz, 1H), 7.48-7.39 \text{ (m, 4H), 7.34 (t, } J = 7.4 \text{ Hz, 2H), 7.20 (d, } J = 7.6 \text{ Hz, 2H), 7.14-6.98 \text{ (m, 3H). MP: 108-110 °C (from ethyl acetate-hexane). The analytical data are consistent with the literature.}}^{1}
\]

\textit{(E)-1,3-dimethyl-5-(1-phenyl-2-(phenylsulfonyl)vinyl)benzene (3h)}

\[
\text{Purification by column chromatography (silica gel, PE:EA = 10:1, 5 x 20 cm) and recrystallization afforded the product as white solid; 0.87 g, yield: 25\% (three steps); }^{1} \text{H NMR (600 MHz, Chloroform-\textit{d}) } \delta 7.64-7.55 \text{ (m, 2H), 7.47 (t, } J = 7.4 \text{ Hz, 1H), 7.40-7.32 \text{ (m, 3H), 7.32-7.27 \text{ (m, 2H), 7.13-6.97 \text{ (m, 4H), 6.81 (s, 2H), 2.25 \text{ (s, 6H). MP: 123-125 °C (from ethyl acetate-hexane). The analytical data are consistent with the literature.}}^{1}
\]

\textit{(E)-1-chloro-4-(2-(phenylsulfonyl)-1-(p-tolyl)vinyl)benzene (3i)}
Purification by column chromatography (silica gel, PE:EA = 10:1, 5 × 20 cm) and recrystallization afforded the product as white solid; 0.85 g, yield: 23% (three steps); $^1$H NMR (600 MHz, Chloroform-$d$) $\delta$ 7.61 (dd, $J = 8.4, 1.2$ Hz, 2H), 7.52-7.49 (m, 1H), 7.38-7.35 (m, 2H), 7.28-7.26 (m, 2H), 7.15-7.13 (m, 2H), 7.11 (d, $J = 7.8$ Hz, 2H), 6.99-6.96 (m, 2H), 6.93 (s, 1H), 2.39 (s, 3H). $^{13}$C NMR (100 MHz, Chloroform-$d$) $\delta$ 153.5, 140.9, 138.8, 137.4, 136.0, 132.4, 131.7, 129.3, 129.1, 128.3, 128.2, 127.2, 20.9. MP: 76-78 °C (from ethyl acetate-hexane). TOF-HRMS Calculated for C$_{21}$H$_{18}$O$_2$ClS ([M+H]$^+$): 369.0711, found 369.0715.

($E$)-1-fluoro-4-(2-(phenylsulfonyl)-1-(p-tolyl)vinyl)benzene (3j)

Purification by column chromatography (silica gel, PE:EA = 10:1, 5 × 20 cm) and recrystallization afforded the product as light yellow solid; 1.09 g, yield: 31% (three steps); $^1$H NMR (400 MHz, Chloroform-$d$) $\delta$ 7.64-7.58 (m, 2H), 7.53-7.47 (m, 1H), 7.39-7.34 (m, 2H), 7.22-7.17 (m, 2H), 7.13-7.08 (m, 2H), 7.01-6.95 (m, 4H), 6.91 (s, 1H), 2.39 (s, 3H). MP: 110-112 °C (from ethyl acetate-hexane). The analytical data are consistent with the literature.$^1$

($E$)-1-methyl-3-(2-(phenylsulfonyl)-1-(p-tolyl)vinyl)benzene (3k)

Purification by column chromatography (silica gel, PE : EA = 15 : 1, 5 × 20 cm) and recrystallization afforded the product as white solid; Yield: 32% (three steps); $^1$H NMR (600 MHz, Chloroform-$d$) $\delta$ 7.61 (dd, $J = 8.4, 1.2$ Hz, 2H), 7.51-7.47 (m, 1H), 7.37-7.33 (m, 2H), 7.18 (d, $J = 4.8$ Hz, 2H), 7.09 (d, $J = 7.8$ Hz, 2H), 7.03 (s, 1H), 7.00-6.96 (m, 3H), 6.94 (s, 1H), 2.39 (s, 3H), 2.30 (s, 3H). MP: 127-129 °C (from ethyl acetate-hexane). The analytical data are consistent with the literature.$^1$

($Z$)-1-fluoro-3-(2-(phenylsulfonyl)-1-(m-tolyl)vinyl)benzene (3l)

Purification by column chromatography (silica gel, PE:EA = 10:1, 5 × 20 cm) and recrystallization afforded the product as white solid; 0.81 g, yield: 27% (three steps); $^1$H NMR (600 MHz, Chloroform-$d$) $\delta$ 7.56 (dd, $J = 8.4, 1.2$ Hz, 2H), 7.48 (d, $J = 7.8$ Hz, 2H), 7.37 (m, 1H), 7.27 (d, $J = 4.8$ Hz, 2H), 7.16 (m, 3H), 7.08 (s, 1H), 7.01-6.88 (m, 3H), 6.93 (s, 1H), 2.39 (s, 3H), 2.33 (s, 3H). MP: 143-144 °C (from ethyl acetate-hexane). The analytical data are consistent with the literature.$^1$
MHz, Chloroform-d) δ 7.66-7.61 (m, 2H), 7.55-7.51 (m, 1H), 7.39 (t, J = 6.3 Hz, 2H), 7.32-7.27 (m, 1H), 7.24-7.18 (m, 2H), 7.09-7.02 (m, 3H), 7.00-6.92 (m, 2H), 6.76-6.65 (m, 1H), 2.31 (s, 3H). MP: 77-79 °C (from ethyl acetate-hexane). The analytical data are consistent with the literature.\(^1\)

(E)-3-(1-phenyl-2-(phenylsulfonyl)vinyl)pyridine (3m)

\[
\begin{align*}
\text{SO}_2\text{Ph} & \quad E/Z \ (9:1) \\
\text{N} & \\
\end{align*}
\]

Purification by column chromatography (silica gel, PE:EA = 1:1, 5 × 20 cm) afforded the product as white solid; 1.81 g, yield: 56%; \(^1\)H NMR (600 MHz, Chloroform-d) δ 8.85 (dd, J = 4.9, 1.8 Hz, 1H), 8.49 (d, J = 2.2 Hz, 1H), 7.87-7.85 (m, 2H), 7.78-7.74 (m, 2H), 7.66-7.60 (m, 3H), 7.57-7.50 (m, 3H), 7.42-7.40 (m, 2H), 7.31 (s, 1H). \(^{13}\)C NMR (151 MHz, Chloroform-d) δ 151.5, 150.1, 149.6, 141.4, 138.4, 137.4, 133.5, 130.9, 130.1, 129.2, 129.0, 128.2, 127.6, 122.9. MP: 90-92 °C (from ethyl acetate-hexane). TOF-HRMS Calculated for C\(_{19}\)H\(_{16}\)N\(_2\)O\(_2\)S ([M+H]\(^+\)): 322.0896, found 322.0902.

1-Methyl-4-(2-(methylsulfonyl)-1-phenylvinyl)benzene (3n)

\[
\begin{align*}
\text{SO}_2\text{Me} & \quad E/Z \ (9:1) \\
\end{align*}
\]

Purification by column chromatography (silica gel, PE:EA = 5:1, 5 × 20 cm) afforded the product as white solid; 0.65 g, yield: 79%; \(^1\)H NMR (600 MHz, Chloroform-d) δ 7.46-7.44 (m, 2H), 7.38-7.36 (m, 2H), 7.29-7.28 (m, 2H), 7.26-7.25 (m, 1H), 7.17 (s, 2H), 6.84 (s, 1H), 2.66 (s, 3H), 2.37 (s, 3H). MP: 104-106 °C (from ethyl acetate-hexane). The analytical data are consistent with the literature.\(^6\)

4. General procedure for asymmetric hydrogenation of 1 and 3.

A stock solution was made by mixing 1.0 mol % Ni(OAc)\(_2\)·H\(_2\)O with 1.1 mol % (S,S)-Ph-BPE in solvent (CF\(_3\)CH\(_2\)OH) at room temperature for 12 hours in a nitrogen-filled glovebox. An aliquot of the catalyst solution (1.0 mL, 0.00125 mmol) was transferred by syringe into the vials charged with different substrates (0.125 mmol for each) and added additive HOAc. The vials were subsequently transferred into which hydrogen gas was charged. The reaction was then stirred under H\(_2\) (50 atm) at 80 °C for 24 h. The hydrogen gas was released slowly and carefully. The solution was passed through a short column of silica gel to remove the metal complex. The conversion of products
were determined by GC or \(^1\)H NMR analysis. The crude products were concentrated and purified by flash column chromatography and the ee values were determined by HPLC, SFC analysis on a chiral stationary phase.

**Gram scale experiment:** A stock solution was made by mixing 1 mol % Ni(OAc)$_2$·H$_2$O with 1.1 mol % (S,S)-Ph-BPE in solvent (CF$_3$CH$_2$OH) at room temperature for 24 hours in a nitrogen-filled glovebox. An aliquot of the catalyst solution (5.0 mL, 0.00125 mmol) was transferred by syringe into the vials charged with substrates (E)-1a (3.62 mmol, 1.0 g) and added additive HOAc. The vials were subsequently transferred into which hydrogen gas was charged. The reaction was then stirred under H$_2$ (50 atm) at 80 °C for 24 h. The hydrogen gas was released slowly and carefully. The solution was passed through a short column of silica gel to remove the metal complex. The solid was washed with CH$_2$Cl$_2$, and filtered to give the product 2a as a white solid (0.96 g, 95% yield) with 94% ee determined by SFC with a chiral column.

A stock solution was made by mixing 1 mol % Ni(OAc)$_2$·H$_2$O with 1.1 mol % (R,R)-Ph-BPE in solvent (CF$_3$CH$_2$OH) at room temperature for 24 hours in a nitrogen-filled glovebox. An aliquot of the catalyst solution (0.003 mmol) was transferred by syringe into the vials charged with substrates (E)-1p (3 mmol, 0.93 g) and added additive HOAc. The vials were subsequently transferred into which hydrogen gas was charged. The reaction was then stirred under H$_2$ (80 atm) at 80 °C for 4 d. The hydrogen gas was released slowly and carefully. The solution was passed through a short column of silica gel to remove the metal complex. The solid was washed with CH$_2$Cl$_2$, and filtered to give the product 2p as a white solid (0.88 g, 94% yield) with 97% ee determined by SFC with a chiral column.

A stock solution was made by mixing 1 mol % Ni(OAc)$_2$·H$_2$O with 1.1 mol % (R,R)-Ph-BPE in solvent (CF$_3$CH$_2$OH) at room temperature for 24 hours in a nitrogen-filled glovebox. An aliquot of the catalyst solution (0.003 mmol) was transferred by syringe into the vials charged with substrates (E)-3h (3 mmol, 1.05 g) and added additive HOAc. The vials were subsequently transferred into which hydrogen gas was
charged. The reaction was then stirred under H₂ (80 atm) at 80 °C for 4 d. The hydrogen gas was released slowly and carefully. The solution was passed through a short column of silica gel to remove the metal complex. The solid was washed with CH₂Cl₂, and filtered to give the product 4h as a white solid (0.66 g, 63% yield) with 99% ee determined by SFC with a chiral column.

5. NMR, GC or HPLC, optical rotation and HRMS Data of compound 2 and 4.

1-Fluoro-3-(1-(phenylsulfonyl)propan-2-yl)benzene (2a)

Purification by flash column chromatography (silica gel, PE:EA = 5:1) afforded the product as white solid; 33.3 mg, yield: 96%; 94 ee; [α]D²⁰ = + 9.1 (c = 1.0, CH₂Cl₂); SFC conditions (Lux 5u Amylose-1, column temperature: 37.0 °C, MeOH/CO₂ = 10/90, flow rate = 3.0 mL/min, tᵣ = 4.0 min (minor), 4.8 min (major); ¹H NMR (600 MHz, Chloroform-d) δ 7.81-7.77 (m, 2H), 7.60-7.56 (m, 1H), 7.50-7.46 (m, 2H), 7.19-7.15 (m, 1H), 6.87-6.81 (m, 2H), 6.76-6.72 (m, 1H), 3.43-3.37 (m, 2H), 3.34-3.29 (m, 1H), 1.42 (d, J = 6.9 Hz, 3H). MP: 50-52 °C (from ethyl acetate-hexane). The analytical data are consistent with the literature.¹

1-Fluoro-2-(1-(phenylsulfonyl)propan-2-yl)benzene (2b)

Purification by flash column chromatography (silica gel, PE:EA = 5:1) afforded the product as white solid; 33.7 mg, yield: 97%; 98% ee; [α]D²⁰ = + 21.1 (c = 1.0, CH₂Cl₂); SFC conditions (Lux 5u Amylose-1, column temperature: 37.0 °C, MeOH/CO₂ = 20/80, flow rate = 3.0 mL/min, tᵣ = 2.5 min (minor), 2.7 min (major); ¹H NMR (600 MHz, Chloroform-d) δ 7.79 (dd, J = 8.3, 1.1 Hz, 2H), 7.59-7.55 (m, 1H), 7.46 (d, J = 7.8 Hz, 2H), 7.14-7.10 (m, 2H), 7.03-6.99 (m, 1H), 6.88-6.83 (m, 1H), 3.60-3.54 (m, 2H), 3.41-3.35 (m, 1H), 1.45 (d, J = 6.9 Hz, 3H). MP: 47-49 °C (from ethyl acetate-hexane). The analytical data are consistent with the literature.¹

1-Fluoro-4-(1-(phenylsulfonyl)propan-2-yl)benzene (2c)

Purification by flash column chromatography (silica gel, PE:EA = 5:1) afforded the product as white solid; 33.7 mg,
yield: 97%; 96% ee; [α]D^20 = +4.5 (c = 1.7, CH₂Cl₂); SFC conditions (Lux 5u Amylose-1, column temperature: 37.0 °C, MeOH/CO₂ = 20/80, flow rate = 3.0 mL/min, l = 210 nm) tᵣ = 4.3 min (major), 5.0 min (minor); ^1H NMR (400 MHz, Chloroform-d) δ 7.80-7.75 (m, 2H), 7.61-7.57 (m, 1H), 7.50-7.45 (m, 2H), 7.06-7.01 (m, 2H), 6.92-6.86 (m, 2H), 3.44-3.30 (m, 3H), 1.41 (d, J = 6.8 Hz, 3H). MP: 59-61 °C (from ethyl acetate-hexane). The analytical data are consistent with the literature.¹

1-Chloro-3-(1-(phenylsulfonyl)propan-2-yl)benzene (2d)

Purification by flash column chromatography (silica gel, PE:EA = 5:1) afforded the product as light yellow liquid; 36.0 mg, yield: 98%; 96% ee; [α]D^20 = +10.8 (c = 1.0, CH₂Cl₂); SFC conditions (Lux 5u Amylose-1, column temperature: 37.0 °C, MeOH/CO₂ = 20/80, flow rate = 3.0 mL/min, l = 210 nm) tᵣ = 2.9 min (minor), 3.5 min (major); ^1H NMR (400 MHz, Chloroform-d) δ 7.78 (dd, J = 8.3, 1.1 Hz, 2H), 7.61-7.56 (m, 1H), 7.47 (t, J = 7.7 Hz, 2H), 7.15-7.10 (m, 2H), 7.02-6.96 (m, 2H), 3.43-3.38 (m, 2H), 3.36-3.29 (m, 1H), 1.42 (d, J = 6.6 Hz, 3H). The analytical data are consistent with the literature.¹

(R)-1-chloro-4-(1-(phenylsulfonyl)propan-2-yl)benzene (2e)

Purification by flash column chromatography (silica gel, PE:EA = 5:1) afforded the product as white solid; 35.3 mg, yield: 96%; 92% ee; [α]D^20 = + 6.3 (c = 1.0, CHCl₃); SFC conditions (Lux 5u Amylose-1, column temperature: 37.0 °C, MeOH/CO₂ = 20/80, flow rate = 3.0 mL/min, l = 210 nm) tᵣ = 4.3 min (major), 5.0 min (minor); ^1H NMR (400 MHz, Chloroform-d) δ 7.80-7.74 (m, 2H), 7.62-7.57 (m, 1H), 7.50-7.44 (m, 2H), 7.19-7.14 (m, 2H), 7.03-6.97 (m, 2H), 3.43-3.31 (m, 3H), 1.41 (d, J = 6.7 Hz, 3H). MP: 63-65 °C (from ethyl acetate-hexane). The absolute configuration of (R)-2e was determined by comparison with optical rotation data for the reported literature.³

1-Bromo-3-(1-(phenylsulfonyl)propan-2-yl)benzene (2f)

Purification by flash column chromatography (silica gel, PE:EA = 5:1) afforded the product as light yellow liquid; 41.0 mg, yield: 97%; 95% ee; [α]D^20 = +2.3 (c = 1.0, CH₂Cl₂);
SFC conditions (Lux 5u Amylose-1, column temperature: 37.0 °C, MeOH/CO₂ = 10/90, flow rate = 3.0 mL/min, l = 210 nm) tᵣ = 6.1 min (minor), 7.7 min (major); ¹H NMR (400 MHz, Chloroform-d) δ 7.80-7.74 (m, 2H), 7.61-7.56 (m, 1H), 7.47 (d, J = 15.5 Hz, 2H), 7.29-7.25 (m, 1H), 7.16 (t, J = 1.8 Hz, 1H), 7.08 (t, J = 7.8 Hz, 1H), 7.04-6.99 (m, 1H), 3.44-3.36 (m, 2H), 3.36-3.30 (m, 1H), 1.41 (d, J = 6.6 Hz, 3H). The analytical data are consistent with the literature.¹

1-Bromo-4-(1-(phenylsulfonyl)propan-2-yl)benzene (2g)

Purification by flash column chromatography (silica gel, PE:EA = 5:1) afforded the product as white solid; 41.0 mg, yield: 97%; 92% ee; [α]D₂₀ = +12.3 (c = 1.0, CH₂Cl₂); SFC conditions (Lux 5u Amylose-1, column temperature: 37.0 °C, MeOH/CO₂ = 20/80, flow rate = 3.0 mL/min, l = 210 nm) tᵣ = 5.5 min (major), 6.7 min (minor); ¹H NMR (600 MHz, Chloroform-d) δ 7.79-7.74 (m, 2H), 7.62-7.58 (m, 1H), 7.47 (t, J = 7.9 Hz, 2H), 7.31 (dd, J = 8.7, 2.0 Hz, 2H), 6.94 (d, J = 8.4 Hz, 2H), 3.41-3.37 (m, 2H), 3.32 (dd, J = 15.8, 9.1 Hz, 1H), 1.40 (d, J = 6.7 Hz, 3H). ¹³C NMR (100 MHz, Chloroform-d) δ = 142.7, 139.7, 133.4, 131.7, 129.1, 128.5, 127.7, 120.6, 63.1, 34.6, 22.2; MP: 85-87 °C (from ethyl acetate-hexane). TOF-HRMS Calculated for C₁₅H₁₆O₂BrS ([M+H]⁺): 339.0048, found 339.0053.

1-Methoxy-2-(1-(phenylsulfonyl)propan-2-yl)benzene (2h)

Purification by flash column chromatography (silica gel, PE:EA = 5:1) afforded the product as white solid; 34.8 mg, yield: 96%; 94% ee; [α]D₂₀ = +8.5 (c = 1.0, CH₂Cl₂); SFC conditions (Lux 5u Cellulose-4, column temperature: 37.0 °C, MeOH/CO₂ = 20/80, flow rate = 3.0 mL/min, l = 210 nm) tᵣ = 4.4 min (major), 5.0 min (minor); ¹H NMR (600 MHz, Chloroform-d) δ 7.78 (dd, J = 8.3, 1.2 Hz, 2H), 7.59-7.54 (m, 1H), 7.48-7.44 (m, 2H), 6.86-6.82 (m, 1H), 7.06 (dd, J = 7.5, 1.6 Hz, 1H), 6.86-6.82 (m, 1H), 6.66 (d, J = 8.2 Hz, 1H), 3.64-3.57 (m, 5H), 3.31 (dd, J = 14.1, 7.6 Hz, 1H), 1.43 (d, J = 7.0 Hz, 3H). MP: 50-52 °C (from ethyl acetate-hexane). The analytical data are consistent with the literature.¹

1-Methoxy-3-(1-(phenylsulfonyl)propan-2-yl)benzene (2i)
Purification by flash column chromatography (silica gel, PE:EA = 5:1) afforded the product as light yellow liquid; 34.0 mg, yield: 94%; 96% ee; \([\alpha]_D^{20} = + 11.2\) (c = 1.1, CH2Cl2); SFC conditions (Lux 5u Amylose-1, column temperature: 37.0 °C, MeOH/CO2 = 20/80, flow rate = 3.0 mL/min, l = 210 nm) \(t_R = 4.3\) min (major), 4.7 min (minor); \(^1\)H NMR (600 MHz, Chloroform-\(d\)) \(\delta 7.83-7.77\) (m, 2H), 7.61-7.55 (m, 1H), 7.48 (t, \(J = 7.8\) Hz, 2H), 7.13 (t, \(J = 7.9\) Hz, 1H), 6.70-6.65 (m, 2H), 6.60-6.57 (m, 1H), 3.74 (s, 3H), 3.43-3.36 (m, 2H), 3.35-3.31 (m, 1H), 1.43 (d, \(J = 6.7\) Hz, 3H). The analytical data are consistent with the literature.\(^1\)

(R)-1-methyl-4-(1-(phenylsulfonyl)propan-2-yl)benzene (2j)

Purification by flash column chromatography (silica gel, PE:EA = 5:1) afforded the product as white solid; 33.6 mg, yield: 98%; 97% ee; \([\alpha]_D^{20} = + 10.3\) (c = 1.0, CHCl3); SFC conditions (Lux 5u Amylose-1, column temperature: 37.0 °C, MeOH/CO2 = 10/90, flow rate = 3.0 mL/min, l = 210 nm) \(t_R = 6.4\) min (major), 7.4 min (minor); \(^1\)H NMR (600 MHz, Chloroform-\(d\)) \(\delta 7.83-7.77\) (m, 2H), 7.61-7.56 (m, 1H), 7.47 (t, \(J = 7.8\) Hz, 2H), 7.02 (d, \(J = 7.9\) Hz, 2H), 6.96 (d, \(J = 8.0\) Hz, 2H), 3.42-3.31 (m, 3H), 2.28 (s, 3H), 1.42 (d, \(J = 6.8\) Hz, 3H). MP: 59-61 °C (from ethyl acetate-hexane). The absolute configuration of (R)-2j was determined by comparison with optical rotation data for the reported literature.\(^7\)

1-Methyl-2-(1-(phenylsulfonyl)propan-2-yl)benzene (2k)

Purification by flash column chromatography (silica gel, PE:EA = 5:1) afforded the product as light yellow liquid; 33.2 mg, yield: 97%; 93% ee; \([\alpha]_D^{20} = - 4.2\) (c = 1.0, CH2Cl2); SFC conditions (Lux 5u Cellulose-4, column temperature: 37.0 °C, MeOH/CO2 = 20/80, flow rate = 3.0 mL/min, l = 210 nm) \(t_R = 3.8\) min (major), 4.5 min (minor); \(^1\)H NMR (600 MHz, Chloroform-\(d\)) \(\delta 7.81\) (d, \(J = 8.2\) Hz, 2H), 7.61-7.56 (m, 1H), 7.48 (t, \(J = 7.6\) Hz, 2H), 7.09-7.03 (m, 3H), 7.00 (q, \(J = 4.9, 4.2\) Hz, 1H), 3.70-3.64 (m, 1H) 3.39-3.31 (m, 2H), 2.24 (s, 3H), 1.43 (d, \(J = 6.9\) Hz, 3H). The analytical data are consistent with the
(R)-((2-phenylpropyl)sulfonyl)benzene (2l)

Purification by flash column chromatography (silica gel, PE:EA = 5:1) afforded the product as white solid; 31.5 mg, yield: 97%; 99.9% ee; [α] D 20 = +6.2 (c = 1.7, CHCl₃); SFC conditions (Lux 5u Cellulose-1, column temperature: 37.0 °C, MeOH/CO₂ = 20/80, flow rate = 3.0 mL/min, λ = 210 nm) tᵣ = 2.4 min (major), 2.5 min (minor); ¹H NMR (400 MHz, Chloroform-d) δ 7.81 (d, J = 7.6 Hz, 2H), 7.60-7.55 (m, 1H), 7.47 (t, J = 7.8 Hz, 2H), 7.24-7.19 (m, 2H), 7.18-7.13 (m, 1H), 7.10-7.03 (m, 2H), 3.45-3.32 (m, 3H), 1.45 (d, J = 6.5 Hz, 3H). MP: 83-85 °C (from ethyl acetate-hexane). The absolute configuration of (R)-2l was determined by comparison with optical rotation data for the reported literature.

((2-Phenylbutyl)sulfonyl)benzene (2m)

Purification by flash column chromatography (silica gel, PE:EA = 5:1) afforded the product as light yellow solid; 32.8 mg, yield: 96%; 91% ee; [α] D 20 = +6.9 (c = 1.0, CH₂Cl₂); SFC conditions (Lux 5u Amylose-1, column temperature: 37.0 °C, MeOH/CO₂ = 20/80, flow rate = 3.0 mL/min, λ = 210 nm) tᵣ = 2.9 min (major), 3.1 min (minor); ¹H NMR (600 MHz, Chloroform-d) δ 7.72 (d, J = 8.3 Hz, 2H), 7.53 (t, J = 7.5 Hz, 1H), 7.41 (t, J = 7.8 Hz, 2H), 7.23-7.11 (m, 3H), 7.00 (d, J = 7.0 Hz, 2H), 3.44 (dd, J = 6.6, 3.3 Hz, 2H), 3.24-3.07 (m, 1H), 2.06-1.87 (m, 1H), 1.70-1.61 (m, 1H), 0.75 (t, J = 7.3 Hz, 3H). MP: 60-62 °C (from ethyl acetate-hexane). The analytical data are consistent with the literature.

(1-Cyclohexyl-2-(phenylsulfonyl)ethyl)benzene (2n)

Purification by flash column chromatography (silica gel, PE:EA = 5:1) afforded the product as white solid; 40.2 mg, yield: 98%; 99% ee; [α] D 20 = -4.7 (c = 1.0, CH₂Cl₂); SFC conditions (Lux 5u Cellulose-1, column temperature: 37.0 °C, MeOH/CO₂ = 20/80, flow rate = 3.0 mL/min, λ = 210 nm) tᵣ = 3.0 min (minor), 3.3 min (major); ¹H NMR (400 MHz, Chloroform-d) δ 7.64-7.57 (m, 2H), 7.50-7.43 (m, 1H), 7.36-7.30 (m, 2H), 7.24-7.19 (m, 2H), 7.18-7.13 (m, 1H), 7.10-7.03 (m, 2H), 3.45-3.32 (m, 3H), 1.45 (d, J = 6.5 Hz, 3H). MP: 83-85 °C (from ethyl acetate-hexane). The absolute configuration of (R)-2n was determined by comparison with optical rotation data for the reported literature.
7.12-7.05 (m, 3H), 6.93-6.85 (m, 2H), 3.62-3.52 (m, 2H), 3.08-2.99 (m, 1H), 1.84-1.65 (m, 2H), 1.61-1.38 (m, 4H), 1.21-1.12 (m, 1H), 1.11-0.97 (m, 2H), 0.88-0.72 (m, 2H).

$^{13}$C NMR (150 MHz, Chloroform-$d$) $\delta$ 140.2, 139.9, 133.1, 128.9, 128.6, 128.1, 127.9, 126.7, 59.7, 46.6, 43.2, 31.1, 29.9, 26.3, 26.3, 26.2. MP: 85-87 °C (from ethyl acetate-hexane). TOF-HRMS Calculated for C$_{20}$H$_{25}$O$_2$S ([M+H]$^+$): 329.1570, found 329.1576.

1-(1-Phenylsulfonyl)propan-2-yl)naphthalene (2o)

Purification by flash column chromatography (silica gel, PE:EA = 5:1) afforded the product as white solid; 37.5 mg, yield: 97%; 89% ee; $[\alpha]_D^{20} = -95.7$ (c = 1.0, CH$_2$Cl$_2$); SFC conditions (Lux 5u Amylose-1, column temperature: 37.0 °C, MeOH/CO$_2$ = 20/80, flow rate = 3.0 mL/min, l = 210 nm) $t_R$ = 4.3 min (minor), 4.9 min (major); $^1$H NMR (400 MHz, Chloroform-$d$) $\delta$ 7.96-7.91 (m, 1H), 7.83 (t, $J = 5.9$ Hz, 3H), 7.69 (d, $J = 8.0$ Hz, 1H), 7.57 (t, $J = 7.4$ Hz, 1H), 7.51-7.43 (m, 4H), 7.35 (t, $J = 7.6$ Hz, 1H), 7.29 (d, $J = 7.1$ Hz, 1H), 4.38-4.25 (m, 1H), 3.57-3.48 (m, 1H), 3.41-3.32 (m, 1H), 1.67 (d, $J = 6.9$ Hz, 3H). MP: 49-51 °C (from ethyl acetate-hexane). The analytical data are consistent with the literature.$^1$

2-(1-Phenylsulfonyl)propan-2-yl)naphthalene (2p)

Purification by flash column chromatography (silica gel, PE:EA = 5:1) afforded the product as white solid; 37.9 mg, yield: 97%; 97% ee; $[\alpha]_D^{20} = +9.8$ (c = 1.0, CHCl$_3$); SFC conditions (Lux 5u Amylose-1, column temperature: 37.0 °C, MeOH/CO$_2$ = 20/80, flow rate = 3.0 mL/min, l = 210 nm) $t_R$ = 5.4 min (minor), 5.7 min (major); $^1$H NMR (600 MHz, Chloroform-$d$) $\delta$ 7.79-7.74 (m, 3H), 7.73-7.67 (m, 2H), 7.53-7.50 (m, 1H), 7.49-7.42 (m, 3H), 7.39-7.34 (m, 2H), 7.20-7.15 (m, 1H), 3.63-3.56 (m, 1H), 3.55-3.41 (m, 2H), 1.53 (d, $J = 6.9$ Hz, 3H). MP: 59-61 °C (from ethyl acetate-hexane). The analytical data are consistent with the literature.$^3$
Purification by flash column chromatography (silica gel, PE:EA = 5:1) afforded the product as light yellow solid; 32.9 mg, yield: 96%; 99% ee; \([\alpha]_D^{20} = -7.3\) (c = 1.7, CH₂Cl₂); SFC conditions (Lux 5u Amylose-1, column temperature: 37.0 °C, MeOH/CO₂ = 20/80, flow rate = 3.0 mL/min, l = 210 nm) \(t_R = 2.9\) min (minor), 3.0 min (major); \(^1\)H NMR (600 MHz, Chloroform-\(d\)) \(\delta 7.72\) (d, \(J = 8.3\) Hz, 2H), 7.53 (t, \(J = 7.5\) Hz, 1H), 7.41 (t, \(J = 7.8\) Hz, 2H), 7.23-7.11 (m, 3H), 7.00 (d, \(J = 7.0\) Hz, 2H), 3.44 (dd, \(J = 6.6, 3.3\) Hz, 2H). 3.24-3.07 (m, 1H), 2.06-1.87 (m, 1H), 1.70-1.61 (m, 1H), 0.75 (t, \(J = 7.3\) Hz, 3H). MP: 60-62 °C (from ethyl acetate-hexane). The analytical data are consistent with the literature.\(^1\)

### 1-Fluoro-4-((2-phenylpropyl)sulfonyl)benzene (2r)

Purification by flash column chromatography (silica gel, PE:EA = 5:1) afforded the product as white solid; 31.6 mg, yield: 91%; 94% ee; \([\alpha]_D^{20} = +9.5\) (c = 1.0, CH₂Cl₂); SFC conditions (Lux 5u Cellulose-4, column temperature: 37.0 °C, MeOH/CO₂ = 10/90, flow rate = 3.0 mL/min, l = 210 nm) \(t_R = 4.4\) min (major), 4.7 min (minor); \(^1\)H NMR (600 MHz, Chloroform-\(d\)) \(\delta 7.79-7.74\) (m, 2H), 7.23-7.19 (m, 2H), 7.18-7.15 (m, 1H), 7.13-7.08 (m, 2H), 7.07-7.03 (m, 2H), 3.45-3.39 (m, 2H), 3.38-3.33 (m, 1H), 1.43 (d, \(J = 6.8\) Hz, 3H). \(^{13}\)C NMR (100 MHz, Chloroform-\(d\)) \(\delta = 165.5\) (d, \(J = 254.0\) Hz), 143.6, 135.9, 130.7, 130.6, 128.7, 126.8, 116.3, 63.4, 35.2, 22.4; MP: 62-64 °C (from ethyl acetate-hexane); TOF-HRMS Calculated for C\(_{15}\)H\(_{16}\)FO\(_2\)S (\([\text{M+H}]^+\)): 279.0849, found 279.0845.

### 1-Chloro-4-((2-phenylpropyl)sulfonyl)benzene (2s)

Purification by flash column chromatography (silica gel, PE:EA = 5:1) afforded the product as white solid; 36.0 mg, yield: 98%; 98% ee; \([\alpha]_D^{20} = +16.2\) (c = 1.3, CH₂Cl₂); SFC conditions (Lux 5u Cellulose-4, column temperature: 37.0 °C, MeOH/CO₂ = 10/90, flow rate = 3.0 mL/min, l = 210 nm) \(t_R = 5.4\) min (minor), 5.8 min (major); \(^1\)H NMR (400 MHz, Chloroform-\(d\)) \(\delta = 7.67\) (d, \(J = 8.6\) Hz, 2H), 7.40 (d, \(J = 8.5\) Hz, 2H), 7.22-
7.16 (m, 3H), 7.05 (d, \(J = 6.8\) Hz, 2H), 3.46-3.32 (m, 3H), 1.43 (d, \(J = 6.5\) Hz, 3H); MP: 86-90 °C (from ethyl acetate-hexane). The analytical data are consistent with the literature.8

1-Fluoro-3-(1-phenyl-2-(phenylsulfonyl)ethyl)benzene (4a)

\[
\begin{array}{c}
\text{SO}_2\text{Ph} \\
\text{F} \\
\text{F}
\end{array}
\]

E-olefin: Purification by flash column chromatography (silica gel, PE:EA = 5:1) afforded the product as white solid; 41.7 mg, yield: 98%; 98% ee; \([\alpha]_D^{20} = -6.3\) (c = 1.0, CHCl₃); SFC conditions (Lux 5u Cellulose-3, column temperature: 37.0 °C, MeOH/CO₂ = 10/90, flow rate = 3.0 mL/min, 1 = 210 nm) \(t_R = 6.2\) min (minor), 6.5 min (major); \(^1H\) NMR (400 MHz, Chloroform-d) \(\delta 7.66\) (dd, \(J = 8.4, 1.1\) Hz, 2H), 7.54-7.47 (m, 1H), 7.40-7.33 (m, 2H), 7.23-7.10 (m, 6H), 6.95 (d, \(J = 7.7\) Hz, 1H), 6.87-6.77 (m, 2H), 4.63 (t, \(J = 7.1\) Hz, 1H), 3.89 (dd, \(J = 7.1, 1.4\) Hz, 2H). MP: 159-161 °C (from ethyl acetate-hexane). The analytical data are consistent with the literature.¹

Z-olefin: Purification by flash column chromatography (silica gel, PE:EA = 5:1) afforded the product as white solid; 41.2 mg, yield: 97%; 90% ee; \([\alpha]_D^{20} = +5.3\) (c = 1.0, CHCl₃); SFC conditions (Lux 5u Cellulose-3, column temperature: 37.0 °C, MeOH/CO₂ = 10/90, flow rate = 3.0 mL/min, 1 = 210 nm) \(t_R = 6.3\) min (major), 6.7 min (minor); \(^1H\) NMR (400 MHz, Chloroform-d) \(\delta 7.66\) (dd, \(J = 8.4, 1.1\) Hz, 2H), 7.54-7.47 (m, 1H), 7.40-7.33 (m, 2H), 7.23-7.10 (m, 6H), 6.95 (d, \(J = 7.7\) Hz, 1H), 6.87-6.77 (m, 2H), 4.63 (t, \(J = 7.1\) Hz, 1H), 3.89 (dd, \(J = 7.1, 1.4\) Hz, 2H). MP: 159-161 °C (from ethyl acetate-hexane). The analytical data are consistent with the literature.¹

1-Fluoro-4-(1-phenyl-2-(phenylsulfonyl)ethyl)benzene (4b)

\[
\begin{array}{c}
\text{SO}_2\text{Ph} \\
\text{F} \\
\text{F}
\end{array}
\]

Purification by flash column chromatography (silica gel, PE:EA = 5:1) afforded the product as white solid; 41.2 mg, yield: 97%; 99% ee; \([\alpha]_D^{20} = -2.7\) (c = 1.0, CHCl₃); SFC conditions (Lux 5u Cellulose-3, column temperature: 37.0 °C, MeOH/CO₂ = 10/90, flow rate = 3.0 mL/min, 1 = 210 nm) \(t_R = 6.5\) min (minor), 7.6 min (major); \(^1H\) NMR (600 MHz, Chloroform-d) \(\delta 7.63\) (d, \(J = 7.1\) Hz, 2H), 7.55-7.46 (m, 2H), 7.41-7.32 (m, 2H), 7.25 (s, 1H), 7.21-
7.05 (m, 6H), 6.87 (d, J = 8.1 Hz, 2H), 4.74-4.59 (m, 1H), 3.99-3.82 (m, 2H). MP: 159-161 °C (from ethyl acetate-hexane). The analytical data are consistent with the literature.\(^1\)

1-Chloro-4-(1-phenyl-2-(phenylsulfonyl)ethyl)benzene (4c)

\[
\begin{align*}
\text{Purification by flash column chromatography (silica gel, PE:EA} & = 5:1) \text{ afforded the product as white solid; } 43.6 \text{ mg, yield: } 98\%; \\
\text{95\% ee; } [\alpha]_{D}^{20} & = -5.9 \text{ (c = 1.0, CHCl}_3); \\
\text{SFC conditions (Lux 5u Cellulose-3, column temperature: } 37.0 \text{ °C, MeOH/CO}_2 & = 30/70, \text{ flow rate = 3.0 mL/min, l = 210 nm) } t_R = 3.2 \text{ min (minor), } 3.4 \text{ min (major); } ^1\text{H NMR (600 MHz, Chloroform-}d) \\
\delta & 7.64 \text{ (d, } J = 7.5 \text{ Hz, 2H), } 7.52 \text{ (t, } J = 7.5 \text{ Hz, 1H), } 7.39-7.35 \text{ (m, 2H), } 7.22-7.13 \text{ (m, 6H), } 7.10 \text{ (d, } J = 7.2 \text{ Hz, 2H), } 7.06 \text{ (s, 1H), } 4.62 \text{ (t, } J = 7.1 \text{ Hz, 1H), } 3.92-3.84 \text{ (m, 2H).} \\
\text{MP: } 91-93 \text{ °C (from ethyl acetate-hexane). The analytical data are consistent with the literature.} \(^1\)
\end{align*}
\]

1-Methyl-2-(1-phenyl-2-(phenylsulfonyl)ethyl)benzene (4d)

\[
\begin{align*}
\text{Purification by flash column chromatography (silica gel, PE:EA} & = 5:1) \text{ afforded the product as white solid; } 39.9 \text{ mg, yield: } 95\%; \\
\text{90\% ee; } [\alpha]_{D}^{20} & = -15.8 \text{ (c = 1.0, CHCl}_3); \\
\text{SFC conditions (Lux 5u Cellulose-3, column temperature: } 37.0 \text{ °C, MeOH/CO}_2 & = 30/70, \text{ flow rate = 3.0 mL/min, l = 210 nm) } t_R = 2.5 \text{ min (major), } 2.9 \text{ min (minor); } ^1\text{H NMR (600 MHz, Chloroform-}d) \\
\delta & 7.65 \text{ (d, } J = 7.4 \text{ Hz, 2H), } 7.49 \text{ (t, } J = 7.4 \text{ Hz, 1H), } 7.35 \text{ (t, } J = 7.8 \text{ Hz, 2H), } 7.21-7.18 \text{ (m, 2H), } 7.14 \text{ (d, } J = 7.2 \text{ Hz, 3H), } 7.10-6.97 \text{ (m, 4H), } 4.96-4.86 \text{ (m, 1H), } 3.88 \text{ (d, } J = 8.8 \text{ Hz, 2H), } 2.32 \text{ (s, 3H).} \\
\text{MP: } 65-67 \text{ °C (from ethyl acetate-hexane). The analytical data are consistent with the literature.} \(^1\)
\end{align*}
\]

1-Methyl-3-(1-phenyl-2-(phenylsulfonyl)ethyl)benzene (4e)

\[
\begin{align*}
\text{Purification by flash column chromatography (silica gel, PE:EA} & = 5:1) \text{ afforded the product as white solid; } 40.3 \text{ mg, yield: } 96\%; \\
\text{95\% ee; } [\alpha]_{D}^{20} & = -1.6 \text{ (c = 1.0, CHCl}_3); \\
\text{SFC conditions (Lux 5u Cellulose-3, column temperature: } 37.0 \text{ °C, MeOH/CO}_2 & = 30/70, \text{ flow rate = 3.0 mL/min, l = 210 nm) } t_R = 2.6 \text{ min (minor), } 3.0 \text{ min (major); } ^1\text{H NMR (400 MHz, Chloroform-}d) \\
\delta & 7.64 \text{ (d, } J = 7.4 \text{ Hz, 2H), } 7.49 \text{ (t, } J = 7.4 \text{ Hz, 1H), } 7.35 \text{ (t, } J = 7.8 \text{ Hz, 2H), } 7.27-7.18 \text{ (m, 2H), } 7.14 \text{ (d, } J = 7.2 \text{ Hz, 3H), } 7.10-6.97 \text{ (m, 4H), } 4.96-4.86 \text{ (m, 1H), } 3.88 \text{ (d, } J = 8.8 \text{ Hz, 2H), } 2.32 \text{ (s, 3H).} \\
\text{MP: } 65-67 \text{ °C (from ethyl acetate-hexane). The analytical data are consistent with the literature.} \(^1\)
\end{align*}
\]
δ 7.63 (d, J = 7.4 Hz, 2H), 7.48 (t, J = 7.4 Hz, 1H), 7.33 (t, J = 7.7 Hz, 2H), 7.20-7.11 (m, 5H), 7.06 (d, J = 7.6 Hz, 1H), 6.95-6.85 (m, 3H), 4.59 (t, J = 7.0 Hz, 1H), 3.91 (d, J = 7.1 Hz, 2H), 2.21 (s, 3H). MP: 91-93 °C (from ethyl acetate-hexane). The analytical data are consistent with the literature.

1-Methyl-4-(1-phenyl-2-(phenylsulfonyl)ethyl)benzene (4f)

E-olefin: Purification by flash column chromatography (silica gel, PE:EA = 5:1) afforded the product as white solid; 39.9 mg, yield: 95%; 97% ee; [α]D20 = - 2.5 (c = 1.0, CHCl3); SFC conditions (Lux 5u Cellulose-3, column temperature: 37.0 °C, MeOH/CO2 = 30/70, flow rate = 3.0 mL/min, 1 = 210 nm) tr = 2.6 min (minor), 2.9 min (major); 1H NMR (600 MHz, Chloroform-d) δ 7.64 (d, J = 8.0 Hz, 2H), 7.49 (t, J = 7.4 Hz, 1H), 7.36-7.32 (m, 2H), 7.24-7.16 (m, 2H), 7.14-7.10 (m, 3H), 7.03-6.98 (m, 4H), 4.59 (t, J = 7.2 Hz, 1H), 3.90 (d, J = 7.2 Hz, 2H), 2.25 (s, 3H). MP: 149-151 °C (from ethyl acetate-hexane). The analytical data are consistent with the literature.

E/Z (4/5): Purification by flash column chromatography (silica gel, PE:EA = 5:1) afforded the product as white solid; 39.5 mg, yield: 94%; 8% ee; [α]D20 = - 5.2 (c = 1.0, CH2Cl2); SFC conditions (Lux 5u Cellulose-3, column temperature: 37.0 °C, MeOH/CO2 = 20/80, flow rate = 3.0 mL/min, 1 = 210 nm) tr = 4.1 min (minor), 5.1 min (major).

1,2-Dichloro-4-(1-phenyl-2-(phenylsulfonyl)ethyl)benzene (4g)

Purification by flash column chromatography (silica gel, PE:EA = 5:1) afforded the product as white solid; 47.2 mg, yield: 97%; 91% ee; [α]D20 = - 6.4 (c = 1.1, CHCl3); SFC conditions (Lux 5u Amylose-1, column temperature: 37.0 °C, MeOH/CO2 = 30/70, flow rate = 3.0 mL/min, 1 = 210 nm) tr = 4.6 min (minor), 4.9 min (major); 1H NMR (400 MHz, Chloroform-d) δ 7.67-7.63 (m, 2H), 7.53 (t, J = 7.4 Hz, 1H), 7.45-7.33 (m, 3H), 7.24-7.18 (m, 3H), 7.15 (d, J = 2.0 Hz, 1H), 7.10 (d, J = 7.0 Hz, 2H), 7.00 (dd, J = 8.3, 2.0 Hz, 1H), 4.64-4.55 (m, 1H), 3.92-3.79 (m, 2H). MP: 99-101 °C (from ethyl acetate-hexane). The analytical data are consistent with the literature.
1,3-Dimethyl-5-(1-phenyl-2-(phenylsulfonyl)ethyl)benzene (4h)

Purification by flash column chromatography (silica gel, PE:EA = 5:1) afforded the product as white solid; 40.7 mg, yield: 93%; 99% ee; \([\alpha]_D^{20} = -5.0\) (c = 1.0, CHCl₃); SFC conditions (Lux 5u Cellulose-3, column temperature: 37.0 °C, MeOH/CO₂ = 30/70, flow rate = 3.0 mL/min, l = 210 nm) tR = 2.1 min (minor), 2.5 min (major); \(^1\)H NMR (600 MHz, Chloroform-d) δ 7.68-7.58 (m, 2H), 7.54-7.40 (m, 1H), 7.36-7.30 (m, 2H), 7.21-7.11 (m, 5H), 6.72 (d, J = 22.4 Hz, 3H), 4.54 (t, J = 7.1 Hz, 1H), 3.90 (d, J = 7.2 Hz, 2H), 2.18 (s, 6H). MP: 103-105 °C (from ethyl acetate-hexane). The analytical data are consistent with the literature.¹

1-Chloro-4-(2-(phenylsulfonyl)-1-(p-tolyl)ethyl)benzene (4i)

Purification by flash column chromatography (silica gel, PE:EA = 5:1) afforded the product as white solid; 42.6 mg, yield: 92%; 94% ee; \([\alpha]_D^{20} = +4.3\) (c = 1.0, CHCl₃); SFC conditions (Lux 5u Cellulose-3, column temperature: 37.0 °C, MeOH/CO₂ = 30/70, flow rate = 3.0 mL/min, l = 210 nm) tR = 3.0 min (major), 3.4 min (minor); \(^1\)H NMR (400 MHz, Chloroform-d) δ 7.66-7.61 (m, 2H), 7.56-7.50 (m, 1H), 7.36 (t, J = 7.9 Hz, 2H), 7.15-7.12 (m, 2H), 7.08-7.03 (m, 2H), 7.02-6.96 (m, 4H), 4.58 (t, J = 7.2 Hz, 1H), 3.91-3.83 (m, 2H), 2.26 (s, 3H). \(^{13}\)C NMR (100 MHz, Chloroform-d) δ 159.9, 139.2, 137.8, 136.7, 136.3, 132.7, 128.9, 128.7, 128.6, 128.4, 127.4, 126.8, 115.1, 114.9, 61.1, 44.5, 20.4. MP: 156-158 °C (from ethyl acetate-hexane). TOF-HRMS Calculated for C₂₁H₂₀ClO₂S ([M+H]⁺): 371.0867 found 371.0869.

1-Fluoro-4-(2-(phenylsulfonyl)-1-(p-tolyl)ethyl)benzene (4j)

Purification by flash column chromatography (silica gel, PE:EA = 5:1) afforded the product as white solid; 42.0 mg, yield: 95%; 96% ee; \([\alpha]_D^{20} = +2.7\) (c = 1.0, CHCl₃); SFC conditions (Lux 5u Cellulose-3, column temperature: 37.0 °C, MeOH/CO₂ = 30/70, flow rate = 3.0 mL/min, l = 210 nm) tR = 5.4 min (major), 5.9 min (minor); \(^1\)H NMR (400 MHz, Chloroform-d) δ 7.64 (d, J = 9.0 Hz, 2H), 7.52 (t, J = 7.4 Hz, 1H), 7.36 (t,
$J = 7.7 \text{ Hz, 2H}$, $7.12$-$7.05$ (m, 2H), $6.99$ (d, $J = 8.9 \text{ Hz, 4H}$), $6.86$ (t, $J = 8.6 \text{ Hz, 2H}$), $4.59$ (t, $J = 7.1 \text{ Hz, 1H}$), $3.89$-$3.78$ (m, 2H), $2.26$ (s, 3H). MP: $154$-$156 \degree \text{C (from ethyl acetate-hexane)}. \text{The analytical data are consistent with the literature.}^1$

1-Methyl-3-(2-(phenylsulfonyl)-1-(p-tolyl)ethyl)benzene (4k)

Purification by flash column chromatography (silica gel, PE:EA = 5:1) afforded the product as white solid; 41.5 mg, yield: 95%; 97% ee; $[\alpha]_D^{20} = +1.8$ (c =1.0, CHCl$_3$); SFC conditions (Lux 5u Cellulose-3, column temperature: $37.0 \degree \text{C, MeOH/CO}_2 = 30/70$, flow rate = 3.0 mL/min, 1 = 210 nm) $t_R = 2.8$ min (major), 3.0 min (minor); $^1$H NMR (600 MHz, Chloroform-$d$) δ $7.62$ (d, $J = 7.5 \text{ Hz, 2H}$), $7.48$ (t, $J = 7.4 \text{ Hz, 1H}$), $7.33$ (t, $J = 7.7 \text{ Hz, 2H}$), $7.06$ (t, $J = 7.6 \text{ Hz, 1H}$), $7.03$-$6.97$ (m, 4H), $6.92$ (d, $J = 7.3 \text{ Hz, 2H}$), $6.88$ (s, 1H), $4.55$ (t, $J = 7.1 \text{ Hz, 1H}$), $3.89$ (d, $J = 7.1 \text{ Hz, 2H}$), $2.23$ (d, $J = 26.0 \text{ Hz, 6H}$). MP: $116$-$118 \degree \text{C (from ethyl acetate-hexane)}. \text{The analytical data are consistent with the literature.}^1$

1-Fuoro-3-(2-(phenylsulfonyl)-1-(m-tolyl)ethyl)benzene (4l)

Purification by flash column chromatography (silica gel, PE:EA = 5:1) afforded the product as white solid; 40.7 mg, yield: 92%; 96% ee; $[\alpha]_D^{20} = -2.2$ (c =1.1, CHCl$_3$); SFC conditions (Lux 5u Cellulose-3, column temperature: $37.0 \degree \text{C, MeOH/CO}_2 = 30/70$, flow rate = 3.0 mL/min, 1 = 210 nm) $t_R = 2.2$ min (major), 2.6 min (minor); $^1$H NMR (600 MHz, Chloroform-$d$) δ $7.71$-$7.62$ (m, 2H), $7.56$-$7.48$ (m, 1H), $7.41$-$7.33$ (m, 2H), $7.20$-$7.14$ (m, 1H), $7.09$ (t, $J = 7.6 \text{ Hz, 1H}$), $7.02$-$6.91$ (m, 3H), $6.89$ (d, $J = 20.2 \text{ Hz, 1H}$), $6.87$-$6.76$ (m, 2H), $4.59$ (t, $J = 7.1 \text{ Hz, 1H}$), $3.88$ (dd, $J = 7.1$, 1.8 Hz, 2H), $2.23$ (s, 3H). MP: $100$-$102 \degree \text{C (from ethyl acetate-hexane)}. \text{The analytical data are consistent with the literature.}^1$

3-(1-Phenyl-2-(phenylsulfonyl)ethyl)pyridine (4m)

$E/Z$ (9/1): Purification by flash column chromatography (silica gel, PE:EA = 1:2) afforded the product as white solid; 8.1 mg, yield: 20%; 78% ee; $[\alpha]_D^{20} = -0.6$ (c = 0.2, CH$_2$Cl$_2$); SFC conditions (Lux 5u Amylose-1, column temperature: $37.0 \degree \text{C, MeOH/CO}_2 = 30/70$, flow rate = 3.0 mL/min,
$l = 210 \text{ nm}$) $t_R = 9.5 \text{ min (minor), 12.1 \text{ min (major);} \; ^1\text{H NMR (600 MHz, Chloroform-d)} \; \delta 8.5 \ (s, 1\text{H}), 8.39 \ (d, J = 4.0 \text{ Hz, 1H}), 7.68-7.66 \ (m, 2\text{H}), 7.53-7.50 \ (m, 1\text{H}), 7.45 \ (dt, J = 7.9, 2.0 \text{ Hz, 1H}), 7.39-7.36 \ (m, 2\text{H}), 7.23-7.21 \ (m, 2\text{H}), 7.18-7.15 \ (m, 1\text{H}), 7.13-7.09 \ (m, 3\text{H}), 4.67-4.64 \ (m, 1\text{H}), 3.95-3.88 \ (m, 2\text{H}). \; ^{13}\text{C NMR (151 MHz, Chloroform-d)} \; \delta 149.2, 148.3, 140.4, 139.4, 136.8, 134.9, 133.5, 129.1, 129.0, 127.9, 127.4, 123.4, 60.9, 43.8. \; \text{MP: 109-110} \; ^\circ \text{C (from ethyl acetate-hexane). TOF-HRMS Calculated for C}_{19}\text{H}_{18}\text{NO}_{2}\text{S ([M+H]}^+): 324.1053, \text{found } 324.1059.$

E/Z (5/4): Purification by flash column chromatography (silica gel, PE:EA = 5:1) afforded the product as colorless oil; 32.6 mg, yield: 95%; 14% ee; $[^{\alpha}]D_{20}^0 = +2.1 \ (c =1.0, \text{CH}_2\text{Cl}_2); \; \text{SFC conditions (Lux 5u Cellulose-3, column temperature: 37.0} \; ^\circ \text{C, MeOH/CO}_2 = 20/80, \; \text{flow rate } = 3.0 \text{ mL/min, } l = 210 \text{ nm) } t_R = 3.1 \text{ min (minor), 3.3 \text{ min (major);} \; ^1\text{H NMR (600 MHz, Chloroform-d)} \; \delta 7.35-7.33 \ (m, 1\text{H}), 7.33-7.30 \ (m, 3\text{H}), 7.26-7.23 \ (m, 1\text{H}), 7.22-7.21 \ (m, 2\text{H}), 7.15 \ (d, J = 7.9 \text{ Hz, 2H}), 4.64 \ (t, J = 7.3 \text{ Hz, 1H}), 3.80-3.73 \ (m, 2\text{H}), 2.32 \ (s, 3\text{H}), 2.31 \ (s, 3\text{H}). \; ^{13}\text{C NMR (151 MHz, Chloroform-d)} \; \delta 141.9, 138.6, 137.2, 129.9, 129.2, 127.7, 127.7, 127.4, 61.0, 46.0, 42.1, 21.1. \; \text{TOF-HRMS Calculated for C}_{16}\text{H}_{19}\text{O}_{2}\text{S ([M+H]}^+): 275.1100, \text{found } 275.1108.$

6. References
4. H. Guo and S. Ma, Highly regio- and stereoselective palladium(0)-catalyzed addition of organoboronic acids with 1,2-allenic sulfones, sulfoxides, or alkyl- or aryl-


7. NMR, SFC and HPLC spectra

\((E)-1\text{-fluoro-3-}\text{-(1-phenylsulfonyl)prop-1-en-2-yl)benzene (1a)}\)

\[ \text{\(}^{1}\text{H NMR (600 MHz, Chloroform-\text{d})}\]  

\((E)-1\text{-fluoro-2-}\text{-(1-phenylsulfonyl)prop-1-en-2-yl)benzene (1b)}\)

\[ \text{\(}^{1}\text{H NMR (600 MHz, Chloroform-\text{d})}\]
(E)-1-fluoro-4-(1-(phenylsulfonyl)prop-1-en-2-yl)benzene (1c)

\[ \text{\textsuperscript{1}H NMR (400 MHz, Chloroform-\textit{d})} \]

(E)-1-chloro-3-(1-(phenylsulfonyl)prop-1-en-2-yl)benzene (1d)

\[ \text{\textsuperscript{1}H NMR (400 MHz, Chloroform-\textit{d})} \]
(E)-1-chloro-4-(1-(phenylsulfonyl)prop-1-en-2-yl)benzene (1e)

\[ \text{H NMR (400 MHz, Chloroform-}d) \]

(E)-1-bromo-3-(1-(phenylsulfonyl)prop-1-en-2-yl)benzene (1f)

\[ \text{H NMR (400 MHz, Chloroform-}d) \]
(E)-1-bromo-4-(1-(phenylsulfonyl)prop-1-en-2-yl)benzene (1g)

$^1$H NMR (600 MHz, Chloroform- $d$)

$^{13}$C NMR (100 MHz, Chloroform- $d$)
(E)-1-methoxy-2-(1-(phenylsulfonyl)prop-1-en-2-yl)benzene (1h)

$\text{^1H NMR (600 MHz, Chloroform-}d\text{)}$

(E)-1-methoxy-3-(1-(phenylsulfonyl)prop-1-en-2-yl)benzene (1i)

$\text{^1H NMR (600 MHz, Chloroform-}d\text{)}$
(E)-1-methyl-4-(1-(phenylsulfonyl)prop-1-en-2-yl)benzene (1j)

\[
\text{SO}_2\text{Ph}
\]

\(^1\text{H NMR (600 MHz, Chloroform-}d)\)

(E)-1-methyl-2-(1-(phenylsulfonyl)prop-1-en-2-yl)benzene (1k)

\[
\text{SO}_2\text{Ph}
\]

\(^1\text{H NMR (600 MHz, Chloroform-}d)\)
(E)-((2-phenylprop-1-en-1-yl)sulfonyl)benzene (11)

\[
\text{H NMR (400 MHz, Chloroform-}d]\]

(E)-((2-phenylbut-1-en-1-yl)sulfonyl)benzene (1m)

\[
\text{H NMR (600 MHz, Chloroform-}d]\]
(E)-(1-cyclohexyl-2-(phenylsulfonyl)vinyl)benzene (1n)

$^1$H NMR (400 MHz, Chloroform-$d$)

$^{13}$C NMR (150 MHz, Chloroform-$d$)
(E)-1-(1-(phenylsulfonyl)prop-1-en-2-yl)naphthalene (1o)

\[
\text{SO}_2\text{Ph}
\]

$^1$H NMR (400 MHz, Chloroform-$d$)

(E)-2-(1-(phenylsulfonyl)prop-1-en-2-yl)naphthalene (1p)

\[
\text{SO}_2\text{Ph}
\]

$^1$H NMR (400 MHz, Chloroform-$d$)
(Z)-((2-phenylprop-1-en-1-yl)sulfonyl)benzene (1q)

$\text{H NMR (400 MHz, Chloroform-}d\text{)}$

(E)-1-fluoro-4-((2-phenylprop-1-en-1-yl)sulfonyl)benzene (1r)

$\text{H NMR (600 MHz, Chloroform-}d\text{)}$
$^{13}$C NMR (150 MHz, Chloroform-$d$)

$(E)$-1-chloro-4-((2-phenylprop-1-en-1-yl)sulfonyl)benzene ($1s$)

$^1$H NMR (600 MHz, Chloroform-$d$)
(E)-3-(1-(phenylsulfonyl)prop-1-en-2-yl)pyridine (1t)

$\text{H NMR (600 MHz, Chloroform-}d\text{)}$

$\text{C NMR (151 MHz, Chloroform-}d\text{)}$

$^{13}\text{C NMR (151 MHz, Chloroform-}d\text{)}$
(E)-1-fluoro-3-(1-phenyl-2-(phenylsulfonyl)vinyl)benzene (3a)

$^1$H NMR (400 MHz, Chloroform-$d$)

(Z)-1-fluoro-3-(1-phenyl-2-(phenylsulfonyl)vinyl)benzene (3a)

$^1$H NMR (600 MHz, Chloroform-$d$)
(E)-1-fluoro-4-(1-phenyl-2-(phenylsulfonyl)vinyl)benzene (3b)

$^1$H NMR (600 MHz, Chloroform-$d$)

(E)-1-chloro-4-(1-phenyl-2-(phenylsulfonyl)vinyl)benzene (3c)

$^1$H NMR (600 MHz, Chloroform-$d$)
(E)-1-methyl-2-(1-phenyl-2-(phenylsulfonyl)vinyl)benzene (3d)

\[ \text{SO}_2\text{Ph} \]

\[ \begin{array}{c}
\text{1H NMR (600 MHz, Chloroform-}d) \\
\end{array} \]

(E)-1-methyl-3-(1-phenyl-2-(phenylsulfonyl)vinyl)benzene (3e)

\[ \text{SO}_2\text{Ph} \]

\[ \begin{array}{c}
\text{1H NMR (600 MHz, Chloroform-}d) \\
\end{array} \]
(E)-1-methyl-4-(1-phenyl-2-(phenylsulfonyl)vinyl)benzene (3f)

\[
\begin{align*}
\text{SO}_2\text{Ph} \\
\end{align*}
\]

\(^1\text{H NMR (600 MHz, Chloroform-}d)\)

(E)-1,2-dichloro-4-(1-phenyl-2-(phenylsulfonyl)vinyl)benzene (3g)

\[
\begin{align*}
\text{Cl} &\quad \text{Cl} \\
\end{align*}
\]

\(^1\text{H NMR (600 MHz, Chloroform-}d)\)
(E)-1,3-dimethyl-5-(1-phenyl-2-(phenylsulfonyl)vinyl)benzene (3h)

\[ \text{SO}_2\text{Ph} \]

\[ \text{H} \quad \text{NMR} \quad (600 \text{ MHz, Chloroform-}d) \]

(E)-1-chloro-4-(2-(phenylsulfonyl)-1-(p-tolyl)vinyl)benzene (3i)

\[ \text{SO}_2\text{Ph} \]

\[ \text{Cl} \]

\[ \text{H} \quad \text{NMR} \quad (600 \text{ MHz, Chloroform-}d) \]
$^{13}$C NMR (100 MHz, Chloroform-$d$)

(E)-1-fluoro-4-(2-(phenylsulfonyl)-1-(p-tolyl)vinyl)benzene (3j)

$^1$H NMR (400 MHz, Chloroform-$d$)
(E)-1-methyl-3-(2-(phenylsulfonyl)-1-(p-tolyl)vinyl)benzene (3k)

\[ \text{SO}_2\text{Ph} \]

\[ \text{H NMR (600 MHz, Chloroform-d)} \]

(Z)-1-fluoro-3-(2-(phenylsulfonyl)-1-(m-tolyl)vinyl)benzene (3l)

\[ \text{SO}_2\text{Ph} \]

\[ \text{H NMR (600 MHz, Chloroform-d)} \]
(E)-3-(1-phenyl-2-(phenylsulfonyl)vinyl)pyridine (3m)

$^1$H NMR (600 MHz, Chloroform-$d$)

$^{13}$C NMR (151 MHz, Chloroform-$d$)
1-Methyl-4-(2-(methylsulfonyl)-1-phenylvinyl)benzene (3n)

\[
\text{SO}_2\text{Me}
\]

\[
E/Z \ (5/4)
\]

$^1$H NMR (600 MHz, Chloroform-\(d\))

1-Fluoro-3-(1-(phenylsulfonyl)propan-2-yl)benzene (2a)

$^1$H NMR (600 MHz, Chloroform-\(d\))
1-Fluoro-2-(1-(phenylsulfonyl)propan-2-yl)benzene (2b)

\[
\begin{align*}
\text{F} & \quad \text{SO}_2\text{Ph} \\
\text{Ph} &
\end{align*}
\]

$^1$H NMR (600 MHz, Chloroform-$d$)

1-Fluoro-4-(1-(phenylsulfonyl)propan-2-yl)benzene (2c)

\[
\begin{align*}
\text{F} & \quad \text{SO}_2\text{Ph} \\
\text{Ph} &
\end{align*}
\]

$^1$H NMR (400 MHz, Chloroform-$d$)
1-Chloro-3-(1-(phenylsulfonyl)propan-2-yl)benzene (2d)

\[ \text{Cl} \quad \text{SO}_2\text{Ph} \]

\(^1\text{H NMR (400 MHz, Chloroform-} \text{d)}\)

(R)-1-chloro-4-(1-(phenylsulfonyl)propan-2-yl)benzene (2e)

\[ \text{Cl} \quad \text{SO}_2\text{Ph} \]

\(^1\text{H NMR (400 MHz, Chloroform-} \text{d)}\)
1-Bromo-3-(1-(phenylsulfonyl)propan-2-yl)benzene (2f)

$\text{H NMR (400 MHz, Chloroform-}d\text{)}$

1-Bromo-4-(1-(phenylsulfonyl)propan-2-yl)benzene (2g)

$\text{H NMR (600 MHz, Chloroform-}d\text{)}$
$^{13}$C NMR (100 MHz, Chloroform-$d$)

1-Methoxy-2-(1-(phenylsulfonyl)propan-2-yl)benzene (2h)

$^1$H NMR (600 MHz, Chloroform-$d$)
1-Methoxy-3-(1-(phenylsulfonyl)propan-2-yl)benzene (2i)

\[
\text{\textsuperscript{1}H NMR (600 MHz, Chloroform-\textit{d})}
\]

(R)-1-methyl-4-(1-(phenylsulfonyl)propan-2-yl)benzene (2j)

\[
\text{\textsuperscript{1}H NMR (600 MHz, Chloroform-\textit{d})}
\]
1-Methyl-2-(1-(phenylsulfonyl)propan-2-yl)benzene (2k)

(R)-((2-phenylpropyl)sulfonyl)benzene (2l)
((2-Phenylbutyl)sulfonyl)benzene (\textbf{2m})

\[ \text{H NMR (600 MHz, Chloroform-} d) \]

(1-Cyclohexyl-2-(phenylsulfonyl)ethyl)benzene (\textbf{2n})

\[ \text{H NMR (400 MHz, Chloroform-} d) \]

S57
\(^{13}\)C NMR (150 MHz, Chloroform-\(d\))

1-(1-(Phenylsulfonyl)propan-2-yl)naphthalene (2o)

\(^1\)H NMR (400 MHz, Chloroform-\(d\))
2-(1-(Phenylsulfonyl)propan-2-yl)naphthalene (2p)

\[ \text{SO}_2\text{Ph} \]

$^1$H NMR (600 MHz, Chloroform-$d$)

((2-Phenylbutyl)sulfonyl)benzene (2q)

\[ \text{SO}_2\text{Ph} \]

$^1$H NMR (600 MHz, Chloroform-$d$)
1-Fluoro-4-((2-phenylpropyl)sulfonyl)benzene (2r)

$^1$H NMR (600 MHz, Chloroform-\textit{d})

$^{13}$C NMR (100 MHz, Chloroform-\textit{d})
1-Chloro-4-((2-phenylpropyl)sulfonyl)benzene (2s)

\[
\begin{align*}
\text{H NMR (400 MHz, Chloroform-}d) \\
\end{align*}
\]

1-Fluoro-3-(1-phenyl-2-(phenylsulfonyl)ethyl)benzene (4a)

\[
\begin{align*}
\text{H NMR (400 MHz, Chloroform-}d) \\
\end{align*}
\]
$^1$H NMR (400 MHz, Chloroform-$d$)

1-Fluoro-4-(1-phenyl-2-(phenylsulfonyl)ethyl)benzene (4b)

$^1$H NMR (600 MHz, Chloroform-$d$)
1-Chloro-4-(1-phenyl-2-(phenylsulfonyl)ethyl)benzene (4c)

\[ \text{H NMR (600 MHz, Chloroform-}d\text{)} \]

1-Methyl-2-(1-phenyl-2-(phenylsulfonyl)ethyl)benzene (4d)

\[ \text{H NMR (600 MHz, Chloroform-}d\text{)} \]
1-Methyl-3-(1-phenyl-2-(phenylsulfonyl)ethyl)benzene (4e)

$^1$H NMR (400 MHz, Chloroform-$d$)

1-Methyl-4-(1-phenyl-2-(phenylsulfonyl)ethyl)benzene (4f)

$^1$H NMR (600 MHz, Chloroform-$d$)

S64
1,2-Dichloro-4-(1-phenyl-2-(phenylsulfonyl)ethyl)benzene (4g)

$^1$H NMR (400 MHz, Chloroform-$d$)

1,3-Dimethyl-5-(1-phenyl-2-(phenylsulfanyl)ethyl)benzene (4h)

$^1$H NMR (600 MHz, Chloroform-$d$)
1-Chloro-4-(2-(phenylsulfonyl)-1-(μ-tolyl)ethyl)benzene (4i)

^1H NMR (400 MHz, Chloroform-\textit{d})

^13C NMR (100 MHz, Chloroform-\textit{d})
1-Fluoro-4-(2-(phenylsulfonyl)-1-(p-tolyl)ethyl)benzene (4j)

1H NMR (400 MHz, Chloroform-d)

1-Methyl-3-(2-(phenylsulfonyl)-1-(p-tolyl)ethyl)benzene (4k)

1H NMR (600 MHz, Chloroform-d)

S67
1-Fluoro-3-(2-(phenylsulfonyl)-1-(m-tolyl)ethyl)benzene (4I)

\[ \text{SO}_2\text{Ph} \]

\[ \begin{array}{c}
\text{F} \\
\end{array} \]

\[ \begin{array}{c}
\text{Ph} \\
\end{array} \]

\[ \begin{array}{c}
\text{Ph} \\
\end{array} \]

\[ \begin{array}{c}
\text{Ph} \\
\end{array} \]

\[ \begin{array}{c}
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\end{array} \]

\[ \begin{array}{c}
\text{Ph} \\
\end{array} \]

\[ \begin{array}{c}
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\end{array} \]

\[ \begin{array}{c}
\text{Ph} \\
\end{array} \]

\[ \begin{array}{c}
\text{Ph} \\
\end{array} \]

1H NMR (600 MHz, Chloroform-\text{d})

3-(1-Phenyl-2-(phenylsulfonyl)ethyl)pyridine (\textbf{4m})

\[ \text{SO}_2\text{Ph} \]

\[ \begin{array}{c}
\text{Ph} \\
\end{array} \]

\[ \begin{array}{c}
\text{Ph} \\
\end{array} \]

\[ \begin{array}{c}
\text{Ph} \\
\end{array} \]

\[ \begin{array}{c}
\text{Ph} \\
\end{array} \]

\[ \begin{array}{c}
\text{Ph} \\
\end{array} \]

\[ \begin{array}{c}
\text{Ph} \\
\end{array} \]

\[ \begin{array}{c}
\text{Ph} \\
\end{array} \]

\[ \begin{array}{c}
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\end{array} \]

\[ \begin{array}{c}
\text{Ph} \\
\end{array} \]

\[ \begin{array}{c}
\text{Ph} \\
\end{array} \]

\[ \begin{array}{c}
\text{Ph} \\
\end{array} \]

1H NMR (600 MHz, Chloroform-\text{d})
$^{13}$C NMR (151 MHz, Chloroform-$d$)

1-Methyl-4-(2-(methylsulfonyl)-1-phenylethyl)benzene (4n)

$^1$H NMR (600 MHz, Chloroform-$d$)
$^{13}$C NMR (151 MHz, Chloroform-$d$)
1-Fluoro-3-(1-(phenylsulfonyl)propan-2-yl)benzene (2a)

Signal 1: MWD1 C, Sig=210,4 Ref=off

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1-Fluoro-2-(1-(phenylsulfonyl)propan-2-yl)benzene (2b)

Signal 1: MWD1 C, Sig=210,4 Ref=off

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1-Fluoro-4-(1-(phenylsulfonyl)propan-2-yl)benzene (2c)
1-Chloro-3-((1-(phenylsulfonyl)propan-2-yl)benzene (2d)
(R)-1-chloro-4-(1-(phenylsulfonyl)propan-2-yl)benzene (2e)

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1-Bromo-3-(1-(phenylsulfonyl)propan-2-yl)benzene (2f)

Signal 1: MWD1 C, Sig=210,4 Ref=off

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1-Bromo-4-(1-(phenylsulfonyl)propan-2-yl)benzene (2g)

Signal 1: MWD1 C, Sig=210,4 Ref=off

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<td>0.1074</td>
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<tr>
<td>2</td>
<td>6.721</td>
<td>0.1014</td>
<td>55.53214</td>
<td>6.65008</td>
<td>3.8980</td>
</tr>
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</table>
1-Methoxy-2-(1-(phenylsulfonyl)propan-2-yl)benzene (2h)

![Signal 1: MWD1 C, Sig=210,4 Ref=off](image1)

<table>
<thead>
<tr>
<th>Peak RetTime Type Width</th>
<th>Area mAU* s</th>
<th>Height mAU</th>
<th>Area %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4.431</td>
<td>7409.10791</td>
<td>1325.61169</td>
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<tr>
<td>2</td>
<td>4.980</td>
<td>237.69336</td>
<td>38.39271</td>
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</table>
1-Methoxy-3-(1-(phenylsulfonyl)propan-2-yl)benzene (21)

Signal 1: MWD1 C, Sig=210,4 Ref=off

<table>
<thead>
<tr>
<th>Peak</th>
<th>RetTime</th>
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<th>Width</th>
<th>Area</th>
<th>Height</th>
<th>Area %</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>3.302</td>
<td>BB</td>
<td>0.0645</td>
<td>47.55404</td>
<td>10.97623</td>
<td>1.7555</td>
</tr>
<tr>
<td>2</td>
<td>4.659</td>
<td>BB</td>
<td>0.0928</td>
<td>2661.29272</td>
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<td>98.2445</td>
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</table>
(R)-1-methyl-4-(1-(phenylsulfonyl)propan-2-yl)benzene (2j)

Signal 1: MWD1 C, Sig=210,4 Ref=off

<table>
<thead>
<tr>
<th>Peak</th>
<th>RetTime</th>
<th>Type</th>
<th>Width</th>
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<th>Height</th>
<th>Area %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6.445</td>
<td>BB</td>
<td>0.1211</td>
<td>5206.78857</td>
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<td>98.6587</td>
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<tr>
<td>2</td>
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<td>BB</td>
<td>0.1170</td>
<td>70.78779</td>
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</table>
1-Methyl-2-(1-(phenylsulfonyl)propan-2-yl)benzene (2k)

![Graph 1](image1)

Signal 1: MWD1 C, Sig=210,4 Ref=off

<table>
<thead>
<tr>
<th>#</th>
<th>RetTime</th>
<th>Type</th>
<th>Width</th>
<th>Area</th>
<th>Height</th>
<th>Area %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3.829</td>
<td>BV</td>
<td>0.0712</td>
<td>3337.61</td>
<td>918.83</td>
<td>96.34</td>
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<tr>
<td>2</td>
<td>4.479</td>
<td>VV</td>
<td>0.0734</td>
<td>126.77</td>
<td>23.50</td>
<td>3.66</td>
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(R)-((2-phenylpropyl)sulfonyl)benzene (2f)
((2-Phenylbutyl)sulfonyl)benzene (2m)

Signal 1: MWD1 C, Sig=210,4 Ref=off

<table>
<thead>
<tr>
<th>#</th>
<th>RetTime</th>
<th>Type</th>
<th>Width</th>
<th>Area</th>
<th>Height</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.878</td>
<td>BB</td>
<td></td>
<td>0.0561</td>
<td>4963.22998</td>
<td>1392.55737</td>
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<tr>
<td>2</td>
<td>3.058</td>
<td>BB</td>
<td></td>
<td>0.0565</td>
<td>238.73029</td>
<td>67.08261</td>
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</table>
(1-Cyclohexyl-2-(phenylsulfonyl)ethyl)benzene (2n)
1-(1-(Phenylsulfonyl)propan-2-yl)naphthalene (2o)

Signal 1: MWD1 C, Sig=210,4 Ref=off

<table>
<thead>
<tr>
<th>Peak</th>
<th>Ret Time</th>
<th>Type</th>
<th>Width</th>
<th>Area</th>
<th>Height</th>
<th>Area %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4.311</td>
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<td>357.13</td>
<td>64.28927</td>
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<td>BB</td>
<td>0.1011</td>
<td>5961.92969</td>
<td>932.38525</td>
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2-(1-(Phenylsulfonyl)propan-2-yl)naphthalene (2p)

**Signal 1: MWD1 C, Sig=210,4 Ref=off**

<table>
<thead>
<tr>
<th>#</th>
<th>Ret Time [min]</th>
<th>Type</th>
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<th>Area [mAU*s]</th>
<th>Height [mAU]</th>
<th>Area %</th>
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<tbody>
<tr>
<td>1</td>
<td>5.354</td>
<td>VV R</td>
<td>0.090</td>
<td>86.67672</td>
<td>12.11042</td>
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<tr>
<td>2</td>
<td>5.660</td>
<td>VV R</td>
<td>0.1152</td>
<td>5067.42188</td>
<td>682.26141</td>
<td>98.3183</td>
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</table>
((2-Phenylbutyl)sulfonyl)benzene (2q)

Signal 1: MWD1 C, Sig=210,4 Ref=off

<table>
<thead>
<tr>
<th>Peak</th>
<th>RetTime</th>
<th>Type</th>
<th>Width</th>
<th>Area</th>
<th>Height</th>
<th>Area</th>
<th>%</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>2.899</td>
<td>BE</td>
<td>0.0572</td>
<td>21.39146</td>
<td>4.60173</td>
<td>0.5347</td>
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<tr>
<td>2</td>
<td>3.065</td>
<td>RE</td>
<td>0.0594</td>
<td>3978.92700</td>
<td>1046.16272</td>
<td>99.4653</td>
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</table>
1-Fluoro-4-((2-phenylpropyl)sulfonyl)benzene (2r)
1-Chloro-4-((2-phenylpropyl)sulfonyl)benzene (2s)
1-Fluoro-3-(1-phenyl-2-(phenylsulfonyl)ethyl)benzene (4a)

Signal 1: MWD1 C, Sig=210,4 Ref=off

<table>
<thead>
<tr>
<th>Peak</th>
<th>RetTime</th>
<th>Type</th>
<th>Width</th>
<th>Area</th>
<th>Height</th>
<th>Area %</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>6.207</td>
<td>BB</td>
<td>0.0748</td>
<td>62.70038</td>
<td>10.41199</td>
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<tr>
<td>2</td>
<td>6.455</td>
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<td>5546.20654</td>
<td>690.14642</td>
<td>98.8821</td>
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</table>
Signal 1: MWD1 C, Sig=210,4 Ref=off

<table>
<thead>
<tr>
<th>#</th>
<th>RetTime [min]</th>
<th>Type</th>
<th>Width [min]</th>
<th>Area [mAU*s]</th>
<th>Height [mAU]</th>
<th>Area %</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>6.335</td>
<td>BB</td>
<td>0.1145</td>
<td>3056.06982</td>
<td>396.06067</td>
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<tr>
<td>2</td>
<td>6.666</td>
<td>BB</td>
<td>0.0879</td>
<td>158.39606</td>
<td>22.01792</td>
<td>4.9276</td>
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</tbody>
</table>
1-Fluoro-4-(1-phenyl-2-(phenylsulfonyl)ethyl)benzene (4b)
1-Chloro-4-(1-phenyl-2-(phenylsulfonyl)ethyl)benzene (4c)
1-Methyl-2-(1-phenyl-2-(phenylsulfonyl)ethyl)benzene (4d)
1-Methyl-3-(1-phenyl-2-(phenylsulfonyl)ethyl)benzene (4e)
1-Methyl-4-(1-phenyl-2-(phenylsulfonyl)ethyl)benzene (4f)

Signal 1: MWD1 C, Sig=210,4 Ref=off

<table>
<thead>
<tr>
<th>Peak</th>
<th>RetTime</th>
<th>Type</th>
<th>Width</th>
<th>Area</th>
<th>Height</th>
<th>Area</th>
<th>%</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>2.576</td>
<td>VB</td>
<td>0.0493</td>
<td>46.37800</td>
<td>14.32139</td>
<td>1.6351</td>
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<tr>
<td>2</td>
<td>2.878</td>
<td>BB</td>
<td>0.0567</td>
<td>2790.09741</td>
<td>761.91626</td>
<td>98.3649</td>
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</tr>
</tbody>
</table>
Additional Info: Peak(s) manually integrated


**SO₂Ph**

(Rac)

**SO₂Ph**

**E/Z (4/5)**

- **Peak RetTime Type Width Area Height Area %**
- --- | ---- | ---- | ---- | ---- | --- | --- |
- 1 | 4.065 | BV R | 0.0803 | 982.20819 | 188.52686 | 45.8732 |
- 2 | 5.140 | VV R | 0.1126 | 1158.92908 | 157.96118 | 54.1268 |
- **Totals:** | | | | | | 2141.13727 | 346.48804 |
1,2-Dichloro-4-(1-phenyl-2-(phenylsulfonyl)ethyl)benzene (4g)
1,3-Dimethyl-5-(1-phenyl-2-(phenylsulfonyl)ethyl)benzene (4h)

Signal 1: MWD1 C, Sig=210,4 Ref=off

<table>
<thead>
<tr>
<th>Peak</th>
<th>RetTime</th>
<th>Type</th>
<th>Width</th>
<th>Area</th>
<th>Height</th>
<th>Area %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<td>BB</td>
<td>0.0394</td>
<td>45.01714</td>
<td>17.54111</td>
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<tr>
<td>2</td>
<td>2.515</td>
<td>BB</td>
<td>0.0568</td>
<td>7370.02051</td>
<td>2056.44751</td>
<td>99.3929</td>
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</tbody>
</table>
1-Chloro-4-(2-(phenylsulfonyl)-1-\((\rho\text{-tolyl})\text{ethyl}\)benzene (4i)

![Diagram of the compound](image)

<table>
<thead>
<tr>
<th>Peak #</th>
<th>Ret Time (min)</th>
<th>Type</th>
<th>Width (min)</th>
<th>Area (mAU*s)</th>
<th>Height (mAU)</th>
<th>Height Area (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3.047</td>
<td>BB</td>
<td>0.0599</td>
<td>927.22400</td>
<td>240.98590</td>
<td>97.0106</td>
</tr>
<tr>
<td>2</td>
<td>3.431</td>
<td>BB</td>
<td>0.0522</td>
<td>28.57242</td>
<td>7.06819</td>
<td>2.9894</td>
</tr>
</tbody>
</table>
1-Fluoro-4-(2-(phenylsulfonyl)-1-(p-tolyl)ethyl)benzene (4j)

<table>
<thead>
<tr>
<th>Peak</th>
<th>RetTime</th>
<th>Type</th>
<th>Width</th>
<th>Area</th>
<th>Height</th>
<th>Area %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5.416</td>
<td>BB</td>
<td>0.1096</td>
<td>4663.15771</td>
<td>667.00916</td>
<td>97.7510</td>
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<tr>
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<td>BB</td>
<td>0.0961</td>
<td>107.28853</td>
<td>14.53341</td>
<td>2.2490</td>
</tr>
</tbody>
</table>
1-Methyl-3-(2-(phenylsulfonyl)-1-(p-tolyl)ethyl)benzene (4k)

Signal 1: MWD1 C, Sig=210,4 Ref=off

<table>
<thead>
<tr>
<th>Peak</th>
<th>Ret Time [min]</th>
<th>Type</th>
<th>Width [min]</th>
<th>Area [mAU]</th>
<th>Height [mAU]</th>
<th>Area [%]</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>2.800</td>
<td>BB</td>
<td>0.0591</td>
<td>2822.07251</td>
<td>706.34753</td>
<td>98.4496</td>
</tr>
<tr>
<td>2</td>
<td>3.004</td>
<td>BB</td>
<td>0.0511</td>
<td>44.44292</td>
<td>12.92914</td>
<td>1.5504</td>
</tr>
</tbody>
</table>
1-Fluoro-3-(2-(phenylsulfonyl)-1-(m-tolyl)ethyl)benzene (4I)
3-(1-Phenyl-2-(phenylsulfonyl)ethyl)pyridine (4m)

Peak RetTime Type Width Area Height  Area %
# [min] [min] [mAU*5] [mAU]      
1 9.534 VB R 0.2178 323.61502 17.57754 11.0413
2 12.127 BV R 0.2829 2607.32568 117.96249 88.9587

Totals: 2930.94070 135.54003
1-Methyl-4-(2-(methylsulfonyl)-1-phenylethyl)benzene (4n)

Additional Info: Peak(s) manually integrated

---

Peak RetTime Type Width Area Height Area %
-----|---|-----|---|---|---|---|---|
1 3.073 BV 0.0563 3163.39990 872.72650 56.7655
2 3.265 VB 0.0582 2409.35107 643.03876 43.2345
Totals : 5572.75098 1515.76526

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