Supporting Information

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Gold(I)-Catalyzed Enantioselective Synthesis of Functionalized Indenes**

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Supporting Information

General Considerations: All reactions involving air sensitive compounds were carried out under a N₂ atmosphere (99.99%). All glassware was oven-dried (120 °C), evacuated and purged with nitrogen. All common reagents and solvents were obtained from commercial suppliers and used without any further purification. Solvents were dried by standard methods. Hexane and ethyl acetate were purchased as extra pure grade reagents and used as received. TLC was performed on aluminum-backed plates coated with silica gel 60 with F₂₅₄ indicator; the chromatograms were visualized under ultraviolet light and/or by staining with a Ce/Mo reagent and subsequent heating. Rₑ values are reported on silica gel. Flash column chromatography was carried out on silica gel 60, 230-240 mesh. NMR spectra were measured on Varian Mercury-Plus 300 MHz and Varian Inova-400 MHz spectrometers. ¹H NMR: splitting pattern abbreviations are: s, singlet; d, doublet; t, triplet; dd, double doublet; ddd, double doublet of doublets; ddt, double doublet of triplets; td, triplet of doublets; m, multiplet; the chemical shifts are reported in ppm using residual solvent peak as reference. ¹³C NMR spectra were recorded at 75.4 MHz or 100.6 MHz using broadband proton decoupling and chemical shifts are reported in ppm using residual solvent peaks as reference (CDCl₃; δ 77.16) and the multiplicities were determined by DEPT experiments. High resolution mass spectra (HRMS) were recorded on a Micromass Autospec
spectrometer using EI at 70eV. Melting points were measured on a Gallenkamp apparatus using open capillary tubes and are uncorrected. GC-MS and low resolution mass spectra (LRMS) measurements were recorded on an Agilent 6890N/5973 Network GC System, equipped with a HP-5MS column. For the determination of the enantiomeric ratio an Agilent HPLC chromatograph equipped with V-UV Diode-Array detectors was used; Chiralcel-OJ, Chiralcel-OD-H and Chiralpack-AD-H were employed as chiral columns. Gold and silver catalysts were purchased from Aldrich or Strem. Chiral gold (I) complexes L1-8 were prepared according to the methods described in the literature.¹

General procedure for the synthesis of o-(alkynyl)styrene derivatives 1: The starting o-(alkynyl)styrene derivatives 1 were synthesized following a two step protocol that involves a Sonogashira coupling and a subsequent Wittig reaction.

The appropriate alkyne (1.1 equiv., 11 mmol) was added to a solution of the corresponding 2-bromo-benzaldehyde (1 equiv., 10 mmol), Et₂NH (1.5 equiv., 15 mmol, 1.6 mL), CuI (0.5 mmol, 96 mg) and [PdCl₂(Ph₃P)₂] (0.3 mmol, 211 mg) in DMF (5 mL). The resulting mixture was stirred at r.t. until the 2-bromobenzaldehyde was consumed as determined by TLC

or GC-MS. The crude mixture was partitioned between water and CH₂Cl₂ and the solvents were removed under reduced pressure. The residue was purified by flash chromatography using mixtures of hexane and EtOAc as eluents to obtain the corresponding 2-ethynylbenzaldehyde which were used in the next step.

BuLi (1 equiv., 10 mmol, 6.25 mL, 1.6M in hexanes) was added to a solution of the appropriate phosphonium iodide (1.1 equiv., 11 mmol) in THF (30 mL) at 0°C and the resulting mixture was stirred for 30 min at room temperature. The mixture was cooled to 0°C, the appropriate 2-ethynylbenzaldehyde (1 equiv., 10 mmol) was added and the reaction stirred at r.t. until the aldehyde was consumed as determined by TLC or GC-MS. The crude mixture was partitioned between water and CH₂Cl₂ and the solvents were removed under reduced pressure. The residue was purified by flash chromatography using mixtures of hexane and EtOAc as eluents to obtain the corresponding o-(alkynyl)styrene 1.

\[ \text{1a} \]

\begin{center}
\begin{tikzpicture}
  \node[draw] (a) {\text{Ph}};
  \node[draw] (b) at (-0.5,0) {\text{1a}};
  \draw (a) -- (b);
\end{tikzpicture}
\end{center}

1-(2-Methylprop-1-enyl)-2-(2-phenylethynyl)benzene (1a). Colourless oil; yield = 82%; R_f = 0.30 (hexane); ¹H NMR (300 MHz, CDCl₃): δ = 1.98 (s, 3H), 2.10 (s, 3H), 6.74 (s, 1H), 7.25-7.33 (m, 1H), 7.37-7.48 (m, 5H), 7.62-7.70 (m, 3H); ¹³C NMR (CDCl₃, 75.4 MHz): δ = 19.7, 26.8, 88.9, 93.5, 122.6, 123.7, 124.0, 126.0, 127.9, 128.2, 128.4, 129.2,
131.6, 132.2, 136.7, 140.6; LRMS (EI): m/z (%) 232 (M+, 45), 217 (100).

4-Fluoro-2-(2-methylprop-1-enyl)-1-(2-phenylethynyl)benzene (1b). Colourless oil; yield = 81%; Rf = 0.36 (hexane); 1H NMR (300 MHz, CDCl3): \( \delta = 1.91 \) (s, 3H), 2.02 (s, 3H), 6.60 (s, 1H), 6.89-6.96 (m, 1H), 7.06 (dd, \( J = 2.5 \) Hz, \( J = 10.0 \) Hz, 1H), 7.35-7.43 (m, 3H), 7.53-7.59 (m, 3H); 13C NMR (CDCl3, 75.4 MHz): \( \delta = 19.7, 26.9, 87.8, 93.2, 113.3 \) (d, \( 2J_C-F = 22 \) Hz), 116.1 (d, \( 2J_C-F = 22 \) Hz), 118.8 (d, \( 4J_C-F = 3 \) Hz), 123.3 (d, \( 4J_C-F = 2 \) Hz), 123.6, 128.3, 128.5, 131.5, 133.8 (d, \( 3J_C-F = 9 \) Hz), 138.1, 142.9 (d, \( 3J_C-F = 8 \) Hz), 162.1 (d, \( 1J_C-F = 248 \) Hz); LRMS (EI): m/z (%) 250 (M+, 43), 215 (100).

5-(2-Methylprop-1-enyl)-6-(2-phenylethynyl)benzo[d][1,3]dioxole (1c). Brown solid; yield = 75%; m.p. = 84-85 °C; 1H NMR (300 MHz, CDCl3): \( \delta = 1.83 \) (s, 3H), 1.95 (s, 3H), 5.98 (s, 2H), 6.49 (s, 1H), 6.78 (s, 1H), 6.97 (s, 1H), 7.29-7.38 (m, 3H), 7.46-7.52 (m, 2H); 13C NMR (CDCl3, 75.4 MHz): \( \delta = 19.9, 27.0, 99.1, 92.5, 101.6, 109.6, 111.6, 115.9, 124.0, 128.2, 128.6, 131.6, 136.1, 136.3, 145.8, 147.8; \) LRMS (EI): m/z (%) 276 (M+, 100).
1-(Cyclopentylidenemethyl)-2-(2-phenylethynyl)benzene (1d). Colourless oil; yield = 78%; R$_f$ = 0.28 (hexane); $^1$H NMR (300 MHz, CDCl$_3$): $\delta$ = 1.72-1.92 (m, 4H), 2.56-2.71 (m, 4H), 7.01 (s, 1H), 7.23 (t, $J$ = 7.5 Hz, 1H), 7.32-7.47 (m, 4H), 7.55 (d, $J$ = 7.9 Hz, 1H), 7.60-7.67 (m, 3H); $^{13}$C NMR (CDCl$_3$, 75.4 MHz): $\delta$ = 25.7, 27.2, 31.4, 35.9, 88.7, 93.9, 119.1, 122.0, 123.7, 125.6, 127.4, 128.1, 128.2, 128.4, 131.5, 132.4, 140.5, 148.9; LRMS (EI): m/z (%) 258 (M$^+$, 51), 217 (100).

1-(Cyclohexylidenemethyl)-2-(2-phenylethynyl)benzene (1e). Colourless oil; yield = 71%; R$_f$ = 0.21 (hexane); $^1$H NMR (300 MHz, CDCl$_3$): $\delta$ = 1.55-1.80 (m, 6H), 2.30-2.45 (m, 4H), 6.54 (s, 1H), 7.18-7.62 (m, 8H); $^{13}$C NMR (CDCl$_3$, 75.4 MHz): $\delta$ = 26.8, 28.0, 28.9, 30.0, 37.8, 89.0, 93.4, 120.9, 122.8, 123.8, 126.0, 127.9, 128.2, 128.4, 129.4, 131.6, 132.1, 140.6, 144.5; LRMS (EI): m/z (%) 272 (M$^+$, 53), 215 (100).

1-(2-Methylprop-1-enyl)-2-(2-(thiophen-3-yl)ethynyl)benzene (1f). Pale yellow oil; yield = 87%; R$_f$ = 0.32 (hexane); $^1$H NMR (300 MHz, CDCl$_3$): $\delta$ = 1.89 (d, $J$ = 0.9 Hz, 3H), 2.01(d,
\( J = 1.2 \text{ Hz, 3H}, \) 6.60 (d, \( J = 0.9 \text{ Hz, 1H} \)), 7.18-7.24 (m, 2H), 7.30-7.35 (m, 3H), 7.52-7.58 (m, 2H); \(^{13}\text{C NMR (CDCl}_3, 75.4 \text{ MHz):} \delta = 20.0, 27.1, 88.5, 88.8, 122.7, 122.9, 124.2, 125.6, 126.2, 128.0, 128.5, 129.4, 130.2, 132.3, 137.0, 140.7; \text{LRMS (EI): } m/z (\%) 238 (M^+, 72), 223 (100).

![1g](image)

**1-(Hex-1-ynyl)-2-(2-methylprop-1-enyl)benzene (1g).**

Colourless oil; yield = 76%; \( R_f = 0.38 \) (hexane); \(^1\text{H NMR (300 MHz, CDCl}_3\):} \( \delta = 1.98 \) (s, 3H), 2.10 (s, 3H), 6.74 (s, 1H), 7.25-7.33 (m, 1H), 7.37-7.48 (m, 5H), 7.62-7.70 (m, 3H); \(^{13}\text{C NMR (CDCl}_3, 75.4 \text{ MHz):} \delta = 19.7, 26.8, 88.9, 93.5, 122.6, 123.7, 124.0, 126.0, 127.9, 128.2, 128.4, 129.2, 131.6, 132.2, 136.7, 140.6; \text{LRMS (EI): } m/z (\%) 212 (M^+, 5), 155 (100).

![1h](image)

**4-Bromo-2-(2-methylprop-1-enyl)-1-(2-phenylethynyl)benzene (1h).** Brown oil; yield = 74%; \( R_f = 0.44 \) (hexane:EtOAc, 10:1); \(^1\text{H NMR (300 MHz, CDCl}_3\):} \( \delta = 1.88 \) (s, 3H), 2.00 (s, 3H), 6.52 (s, 1H), 7.32-7.46 (m, 6H), 7.51-7.56 (m, 2H); \(^{13}\text{C NMR (CDCl}_3, 75.4 \text{ MHz):} \delta = 19.7, 26.7, 87.8, 94.4, 121.5, 121.9, 122.8, 123.3, 128.4, 129.0, 131.5, 132.0, 133.3, 138.1, 142.3; \text{LRMS (EI): } m/z (\%) 250 (M^+, 43), 215 (100).
General procedure for the gold(I)-catalyzed synthesis of racemic 1H-indenes 2: AgSbF₆ (5 mol%, 8.5 mg) was added to a solution of [AuCl(Ph₃P)] (5 mol%, 12.3 mg) in dry CH₂Cl₂ (1.0 mL) and the reaction mixture was stirred 5-10 minutes. A solution of the corresponding o-(alkynyl)styrene derivative 1 (0.5 mmol) in dry CH₂Cl₂ (1.0 mL) was added and the reaction mixture was stirred at r.t. until complete disappearance of the styrene derivative was observed by TLC or GC-MS (10-30 min). The mixture was filtered through silica gel, the solvent was removed under reduced pressure and the crude mixture was purified by flash chromatography on silica gel using mixtures of hexane and EtOAc as eluents. The corresponding racemic indenes 2 were isolated in the yields reported in the following table.

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2-Phenyl-1-(prop-1-en-2-yl)-1H-indene (2a). White solid; yield = 88%; Rₚ = 0.42 (hexane); m.p. = 101-103 °C; ¹H NMR
(300 MHz, CDCl$_3$): $\delta = 1.21$ (s, 3H), 4.61 (s, 1H), 5.14 (s, 1H), 5.39 (s, 1H), 7.22-7.48 (m, 8H), 7.70-7.76 (m, 2H); $^{13}$C NMR (CDCl$_3$, 75.4 MHz): $\delta = 17.1$, 58.7, 115.1, 120.9, 123.3, 125.3, 126.3, 127.3, 127.6, 128.0, 128.6, 135.6, 144.3, 145.1, 146.4, 148.7; LRMS (EI): $m/z$ (%) 232 (47, M$^+$), 217 (100); HRMS (EI) for C$_{18}$H$_{16}$: 232.1252, found: 232.1244.

![6-Fluoro-2-phenyl-1-(prop-1-en-2-yl)-1H-indene (2b)](image)

6-Fluoro-2-phenyl-1-(prop-1-en-2-yl)-1H-indene (2b). White solid; yield = 80%; $R_f = 0.39$ (hexane); m.p. = 97-98 °C; $^1$H NMR (300 MHz, CDCl$_3$): $\delta = 1.24$ (s, 3H), 4.58 (s, 1H), 5.17 (s, 1H), 5.39 (s, 1H), 7.00-7.25 (m, 1H), 7.16-7.27 (m, 2H), 7.30-7.51 (m, 4H), 7.66-7.75 (m, 2H); $^{13}$C NMR (CDCl$_3$, 75.4 MHz): $\delta = 17.1$, 58.9 (d, $^4$J$_{C-F} = 2$ Hz), 111.0 (d, $^2$J$_{C-F} = 23$ Hz), 114.1 (d, $^2$J$_{C-F} = 22$ Hz), 115.6, 121.4 (d, $^3$J$_{C-F} = 8$ Hz), 126.2, 127.0, 127.6, 128.6, 135.4, 140.2 (d, $^5$J$_{C-F} = 2$ Hz), 144.5, 148.5 (d, $^4$J$_{C-F} = 4$ Hz), 148.7 (d, $^3$J$_{C-F} = 8$ Hz), 161.9 (d, $^1$J$_{C-F} = 243$ Hz); LRMS (EI): $m/z$ (%) 250 (53, M$^+$), 235 (100); HRMS (EI) for C$_{18}$H$_{15}$F: 250.1158, found: 250.1155.

![6-Phenyl-5-(prop-1-en-2-yl)-5H-indeno[5,6-d][1,3]dioxole (2c)](image)

6-Phenyl-5-(prop-1-en-2-yl)-5H-indeno[5,6-d][1,3]dioxole (2c). White solid; yield = 70%; $R_f = 0.16$ (hexane); m.p. = 112-114 °C; $^1$H NMR (300 MHz, CDCl$_3$): $\delta = 1.20$ (s, 3H), 4.47
(s, 1H), 5.10 (s, 1H), 5.34 (s, 1H), 5.98 (s, 2H), 6.91 (d, J = 13 Hz, 2H), 7.15 (s, 1H), 7.23-7.31 (m, 1H), 7.38 (t, J = 7.8 Hz, 2H), 7.61-7.69 (m, 2H); \(^{13}\)C NMR (CDCl\(_3\), 75.4 MHz): \(\delta = 16.9, 58.5, 101.1, 101.7, 104.9, 115.0, 125.9, 127.2, 127.7, 128.6, 135.7, 138.1, 140.6, 145.2, 146.2, 147.2, 147.6\); LRMS (EI): m/z (%) 276 (100, M\(^+\)); HRMS (EI) for C\(_{19}\)H\(_{16}\)O\(_2\): 276.1150, found: 276.1154.

![2d](image)

1-Cyclopent-1-enyl-2-phenyl-1H-indene (2d). White solid; yield = 85%; \(R_{f} = 0.41\) (hexane); m.p. = 133-134 °C; \(^1\)H NMR (300 MHz, CDCl\(_3\)): \(\delta = 1.60-1.90\) (m, 4H), 2.30-2.45 (m, 2H), 4.83 (s, 1H), 5.95 (s, 1H), 7.15-7.50 (m, 8H), 7.64-7.76 (m, 2H); \(^{13}\)C NMR (CDCl\(_3\), 75.4 MHz): \(\delta = 23.4, 30.7, 32.5, 52.5, 120.9, 123.4, 125.2, 126.3, 127.1, 127.4, 127.5, 128.3, 128.5, 135.7, 142.9, 144.1, 146.7, 148.9\); LRMS (EI): m/z (%) 258 (100, M\(^+\)); HRMS (EI) for C\(_{20}\)H\(_{18}\): 258.1409, found: 258.1409.

![2e](image)

1-Cyclohex-1-enyl-2-phenyl-1H-indene (2e). White solid; yield = 90%; \(R_{f} = 0.44\) (hexane); m.p. = 127-129 °C; \(^1\)H NMR (300 MHz, CDCl\(_3\)): \(\delta = 1.20-1.69\) (m, 6H), 2.15-2.27 (m, 2H), 4.50 (s, 1H), 6.11 (s, 1H), 7.21-7.50 (m, 8H), 7.76 (d, J =
8.2 Hz, 2H); $^{13}$C NMR (CDCl$_3$, 75.4 MHz): $\delta$ = 22.5, 22.8, 23.2, 25.8, 59.0, 120.7, 123.2, 125.1, 126.1, 126.2, 127.0, 127.4, 127.8, 128.5, 135.9, 137.3, 144.3, 147.3, 148.8; LRMS (EI): m/z (%) 272 (100, M$^+$), 229 (43); HRMS (EI) for C$_{21}$H$_{20}$: 272.1565, found: 272.1561.

![2f]

$1$-(Prop-1-en-2-yl)-2-(3-thienyl)-1H-indene (2f). White solid; yield = 94%; R$_f$ = 0.36 (hexane); m.p. = 103-104 °C; $^1$H NMR (300 MHz, CDCl$_3$): $\delta$ = 1.28 (s, 3H), 4.51 (s, 1H), 5.20 (s, 1H), 5.43 (s, 1H), 7.13 (s, 1H), 7.22-7.53 (m, 6H), 7.62 (s, 1H); $^{13}$C NMR (CDCl$_3$, 75.4 MHz): $\delta$ = 17.0, 59.5, 115.1, 120.8, 121.0, 123.1, 125.2, 125.5, 126.1, 127.2, 127.3, 137.6, 143.8, 144.4, 145.6, 145.8; LRMS (EI): m/z (%) 238 (82, M$^+$), 223 (100); HRMS (EI) for C$_{16}$H$_{14}$S: 238.0816, found: 238.0813.

![2g]

2-Butyl-1-(prop-1-en-2-yl)-1H-indene (2g). Pale yellow oil; yield = 73%; R$_f$ = 0.48 (hexane); $^1$H NMR (300 MHz, CDCl$_3$): $\delta$ = 1.07 (t, $J$ = 7.3 Hz, 3H), 1.30 (s, 3H), 1.44-1.84 (m, 4H), 2.30-2.54 (m, 2H), 4.07 (s, 1H), 5.17 (s, 1H), 5.27 (s, 1H), 6.64 (s, 1H), 7.18-7.27 (m, 1H), 7.30-7.42 (m, 3H); $^{13}$C NMR (CDCl$_3$, 75.4 MHz): $\delta$ = 14.2, 16.9, 22.8, 29.2, 30.9, 60.7, 115.1, 119.8, 123.1, 124.1, 126.6, 126.9,
144.2, 145.3, 145.8, 152.9; LRMS (EI): m/z (%) 212 (38, M⁺), 128 (100); HRMS (EI) for C₁₆H₂₀: 212.1565, found: 212.1577.

**General procedure for the gold(I)-catalyzed synthesis of racemic 1H-indenes 3:** AgSbF₆ (5 mol%, 8.5 mg) was added to a solution of [AuCl(Ph₃P)] (5 mol%, 12.3 mg) in dry CH₂Cl₂ (1.0 mL) and the mixture stirred for 5-10 minutes. The appropriate nucleophile [ROH (5 equiv., 2.5 mmol) or H₂O (20 equiv., 10 mmol) and o-(alkynyl)styrene 1 (0.5 mmol) in dry CH₂Cl₂ (1.0 mL) were subsequently added. The resulting reaction mixture was stirred at r.t. until complete disappearance of the styrene derivative was observed by TLC or GC-MS (1-3 h). The mixture was filtered through silica gel, the solvent removed and the residue purified by flash chromatography on silica gel using mixtures of hexane and EtOAc as eluents. The corresponding racemic indenes 3 were isolated in the yields reported in the following table.
12 1f H H H Me 3-Thienyl Me 3fa 94
13 1f H H H Me 3-Thienyl H 3fb 84
14 1g H H H Me n-Bu Me 3ga 81
15 1g H H H Me n-Bu H 3gb 78[c]
16 1h H Br H Me Ph Me 3ha 87
17 1h H Br H Me Ph H 3hb 73[c]

[a] Reaction performed using 20 equiv. of i-ProOH.  [b] 8% of 2a was also formed.  [c] [AuNTf₂(Ph₃P)] was used as catalyst.

1-(2-Methoxypropan-2-yl)-2-phenyl-1H-indene  (3aa).  White solid; yield = 90%; R₉ = 0.45 (hexane:EtOAc, 6:1); m.p. = 76-77 °C; ¹H NMR (300 MHz, CDCl₃): δ = 0.84 (s, 3H), 1.03 (s, 3H), 3.42 (s, 3H), 4.36 (s, 1H), 6.92 (s, 1H), 7.22-7.50 (m, 8H), 7.71 (d, J = 7.5 Hz, 1H); ¹³C NMR (CDCl₃, 75.4 MHz): δ = 21.5, 25.5, 49.3, 57.3, 77.8, 120.7, 124.7, 126.1, 127.0, 127.1, 127.8, 128.2, 131.7, 138.9, 144.7, 145.6, 150.6; LRMS (EI): m/z (%) 264 (1, M⁺), 73 (100); HRMS (EI) for C₁₉H₂₅O: 264.1514, found: 264.1503.

1-(2-Hydroxypropan-2-yl)-2-phenyl-1H-indene  (3ab).  Colourless oil; yield = 95%; R₉ = 0.30 (hexane:EtOAc, 5:1); ¹H NMR (300 MHz, CDCl₃): δ = 0.97 (s, 3H), 1.21 (s, 3H), 1.83 (s, 1H), 4.22 (s, 1H), 6.95 (s, 1H), 7.19-7.27 (m, 1H), 7.30-7.46 (m, 5H), 7.51-7.57 (m, 2H), 7.69 (d, J = 7.5 Hz, 1H); ¹³C NMR (CDCl₃, 75.4 MHz): δ = 27.1, 27.8, 61.3, 73.9, 121.1, 124.7, 125.3, 127.3, 127.6, 128.0, 128.6,
131.1, 138.0, 144.8, 145.2, 150.6; LRMS (EI): m/z (%) 250 (1, M'), 192 (100); HRMS (EI) for C\textsubscript{18}H\textsubscript{18}O: 250.1358, found: 250.1351.

![Image of 3ab-D](image)

**3-Deutero-1-(2-hydroxypropan-2-yl)-2-phenyl-1\textsubscript{H}-indene (3ab-D).** Compound obtained using D\textsubscript{2}O as nucleophile; although OD-derivative was formed in the reaction the OH-derivative was isolated after purification by flash chromatography. Colourless oil; yield = 89% (92%-D at C3); R\textsubscript{f} = 0.32 (hexane:EtOAc, 5:1); \textsuperscript{1}H NMR (300 MHz, CDCl\textsubscript{3}): δ = 0.97 (s, 3H), 1.20 (s, 3H), 1.85 (s, 1H), 4.22 (s, 1H), 7.22 (td, J = 7.3 Hz, J = 0.9 Hz, 1H), 7.30-7.46 (m, 5H), 7.50-7.55 (m, 2H), 7.68 (d, J = 7.5 Hz, 1H)); \textsuperscript{13}C NMR (CDCl\textsubscript{3}, 75.4 MHz): δ = 27.1, 27.8, 61.3, 73.9, 121.1, 124.7, 125.3, 127.3, 127.6, 128.0, 128.6, 130.9 (t, J = 24.9 Hz), 138.0, 144.8, 145.2, 150.4; LRMS (EI): m/z (%) 251 (1, M'), 193 (100); HRMS (EI) for C\textsubscript{18}H\textsubscript{17}DO: 251.1420, found: 251.1422.

![Image of 3ac](image)

**1-(2-Ethoxypropan-2-yl)-2-phenyl-1\textsubscript{H}-indene (3ac).** Colourless oil; yield = 85%; R\textsubscript{f} = 0.53 (hexane:EtOAc, 10:1); \textsuperscript{1}H NMR (300 MHz, CDCl\textsubscript{3}): δ = 0.83 (s, 3H), 0.96 (s, 3H), 1.19 (t, J = 7.0 Hz, 3H), 3.47-3.65 (m, 2H), 4.30 (s, 1H), 6.86 (s, 1H), 7.19 (td, J = 1.3 Hz, J = 7.4 Hz, 1H),
7.24-7.45 (m, 7H), 7.68 (d, J = 7.5 Hz, 1H); $^{13}$C NMR (CDCl$_3$, 75.4 MHz): $\delta$ = 15.8, 21.9, 25.7, 56.5, 58.3, 77.7, 120.7, 124.7, 126.2, 126.9, 127.0, 127.9, 128.2, 131.7, 139.2, 144.7, 145.8, 150.8; LRMS (EI): m/z (%) 278 (1, M$^+$), 87 (100); HRMS (EI) for C$_{20}$H$_{22}$O: 278.1671, found: 278.1683.

\[ \text{3ad} \]

1-(2-(Allyloxy)propan-2-yl)-2-phenyl-1H-indene (3ad). Pale yellow oil; yield = 93%; $R_f$ = 0.44 (hexane:EtOAc, 9:1); $^1$H NMR (300 MHz, CDCl$_3$): $\delta$ = 0.82 (s, 3H), 0.99 (s, 3H), 4.03 (ddt, $J$ = 12.0 Hz, $J$ = 5.3 Hz, $J$ = 1.5 Hz, 1H), 4.11 (ddt, $J$ = 12.0 Hz, $J$ = 5.6 Hz, $J$ = 1.4 Hz, 1H), 4.32 (s, 1H), 5.17 (ddd, $J$ = 10.3 Hz, $J$ = 3.1 Hz, $J$ = 1.3 Hz, 1H), 5.31 (ddd, $J$ = 17.2 Hz, $J$ = 3.4 Hz, $J$ = 1.7 Hz, 1H), 5.86-5.98 (m, 1H), 6.86 (s, 1H), 7.17 (td, $J$ = 7.4 Hz, $J$ = 1.3 Hz, 1H), 7.25-7.45 (m, 7H), 7.68 (d, $J$ = 7.5 Hz, 1H); $^{13}$C NMR (CDCl$_3$, 75.4 MHz): $\delta$ = 19.3, 23.4, 55.8, 60.5, 75.7, 113.7, 118.3, 122.3, 123.9, 124.5, 124.6, 125.4, 125.8, 129.4, 133.2, 136.6, 142.2, 143.2, 148.1; LRMS (EI): m/z (%) 290 (1, M$^+$), 98 (100); HRMS (EI) for C$_{21}$H$_{22}$O: 290.1671, found: 290.1671.

\[ \text{3ae} \]
1-(2-iso-Propoxypropan-2-yl)-2-phenyl-1H-indene (3ae). 20 equiv. (10 mmol, 0.77 mL) of isopropanol were employed; 8% of indene 2a was also formed; White solid; yield = 81%; R<sub>f</sub> = 0.61 (hexane:EtOAc, 10:1); m.p. = 76-77 °C; <sup>1</sup>H NMR (300 MHz, CDCl<sub>3</sub>): δ = 0.85 (s, 3H), 0.93 (s, 3H), 1.02 (d, J = 6.1 Hz, 3H), 1.12 (d, J = 6.1 Hz, 3H), 3.78-3.88 (m, 1H), 4.18 (s, 1H), 6.87 (s, 1H), 7.13-7.20 (m, 1H), 7.24-7.39 (m, 5H), 7.42-7.47 (m, 1H); <sup>13</sup>C NMR (CDCl<sub>3</sub>, 75.4 MHz): δ = 21.5, 24.9, 25.2, 25.8, 60.5, 63.3, 78.5, 120.6, 124.4, 126.7, 126.9, 127.0, 128.1, 131.6, 139.4, 144.7, 146.1, 150.8; LRMS (EI): m/z (%) 292 (1, M<sup>+</sup>), 58 (100); HRMS (EI) for C<sub>21</sub>H<sub>24</sub>O: 292.1827, found: 292.1824.

6-Fluoro-1-(2-methoxypropan-2-yl)-2-phenyl-1H-indene (3ba). White solid; yield = 95%; R<sub>f</sub> = 0.44 (hexane:EtOAc, 10:1); m.p. = 79-80 °C; <sup>1</sup>H NMR (300 MHz, CDCl<sub>3</sub>): δ = 0.74 (s, 3H), 1.01 (s, 3H), 3.39 (s, 3H), 4.29 (s, 1H), 6.83 (s, 1H), 6.96-7.06 (m, 1H), 7.22-7.50 (m, 7H); <sup>13</sup>C NMR (CDCl<sub>3</sub>, 75.4 MHz): δ = 20.8, 25.8, 49.3, 57.7 (d, <sup>4</sup>J<sub>C-F</sub> = 2.2 Hz), 77.7, 113.7 (d, <sup>2</sup>J<sub>C-F</sub> = 22.6 Hz), 114.2 (d, <sup>2</sup>J<sub>C-F</sub> = 24.1 Hz), 121.1 (d, <sup>3</sup>J<sub>C-F</sub> = 9.0 Hz), 127.2, 127.7, 128.3, 130.9, 138.7, 140.5 (d, <sup>5</sup>J<sub>C-F</sub> = 2.3 Hz), 147.8 (d, <sup>3</sup>J<sub>C-F</sub> = 9.0 Hz), 150.1 (d, <sup>4</sup>J<sub>C-F</sub> = 3.8 Hz), 161.0 (d, <sup>1</sup>J<sub>C-F</sub> = 240.8 Hz); LRMS (EI): m/z (%) 282 (8, M<sup>+</sup>), 209 (11), 73 (100); HRMS (EI) for C<sub>19</sub>H<sub>19</sub>F: 282.1420, found: 282.1424.
6-Fluoro-1-(2-hydroxypropan-2-yl)-2-phenyl-1H-indene (3bb).

Colourless oil; yield = 76%; R_f = 0.30 (hexane:EtOAc, 5:1);
^1H NMR (300 MHz, CDCl_3): δ = 0.96 (s, 3H), 1.12 (s, 3H),
1.80 (s, 1H), 4.17 (s, 1H), 6.86 (s, 1H), 7.01–7.06 (m, 1H),
7.24–7.50 (m, 7H); ^13C NMR (CDCl_3, 75.4 MHz): δ = 26.6,
28.5, 61.4 (d, J_C-F = 2.3 Hz), 73.9, 113.6 (d, J_C-F = 23.4 Hz),
114.0 (d, J_C-F = 22.6 Hz), 121.5 (d, J_C-F = 8.3 Hz),
127.7, 127.9, 128.6, 130.3, 137.8, 140.7 (d, J_C-F = 2.3 Hz),
147.4 (d, J_C-F = 8.3 Hz), 150.2 (d, J_C-F = 4 Hz), 161.1
(d, J_C-F = 241.5 Hz); LRMS (EI): m/z (%) 268 (7, M^+), 210
(100); HRMS (EI) for C_{18}H_{17}F: 268.1263, found: 268.1273.

5-(2-Methoxypropan-2-yl)-6-phenyl-5H-indeno[5,6-d][1,3]
dioxole (3ca). White solid; yield = 98%; R_f = 0.61
(hexane:EtOAc, 10:1); m.p. = 123–125 °C; ^1H NMR (300 MHz,
CDCl_3): δ = 0.74 (s, 3H), 0.99 (s, 3H), 3.37 (s, 3H), 4.20
(s, 1H), 5.96–5.98 (m, 2H), 6.76 (s, 1H), 6.84 (s, 1H),
7.22 (s, 1H), 7.23–7.42 (m, 5H); ^13C NMR (CDCl_3, 75.4 MHz):
δ = 20.8, 25.8, 49.2, 57.0, 77.8, 100.9, 101.5, 108.0,
126.9, 127.7, 128.2, 131.4, 138.4, 138.9, 139.7, 145.6,
146.7, 149.3; LRMS (EI): m/z (%) 308 (9, M^+), 73 (100); HRMS (EI) for C_{20}H_{20}O_3: 308.1412, found: 308.1414.
5-(2-Methoxypropan-2-yl)-6-phenyl-5H-indeno[5,6-d][1,3]dioxole (3cb). White solid; yield = 72%; $R_f = 0.13$ (hexane:EtOAc, 5:1); m.p. = 118-120 °C; $^1$H NMR (300 MHz, CDCl$_3$): $\delta = 0.94$ (s, 3H), 1.12 (s, 3H), 1.70 (s, 1H), 4.07 (s, 1H), 5.97 (dd, $J = 1.3$ Hz, $J = 3.6$ Hz, 2H), 6.79 (s, 1H), 6.84 (s, 1H), 7.20 (s, 1H), 7.24-7.31 (m, 1H), 7.34-7.40 (m, 2H), 7.42-7.47 (m, 2H); $^{13}$C NMR (CDCl$_3$, 75.4 MHz): $\delta = 26.8, 28.3, 60.9, 74.0, 101.1, 102.0, 107.3, 127.4, 127.9, 128.6, 130.8, 138.1, 138.7, 139.2, 145.6, 147.0, 149.5; LRMS (EI): $m/z$ (%) 294 (10, M$^+$), 236 (100), 178 (28); HRMS (EI) for C$_{19}$H$_{18}$O$_3$: 294.1256, found: 294.1255.

1-(1-Methoxycyclopentyl)-2-phenyl-1H-indene (3da). White solid; yield = 96%; $R_f = 0.38$ (hexane:EtOAc, 10:1); m.p. = 98-100 °C; $^1$H NMR (300 MHz, CDCl$_3$): $\delta = 1.10-1.36$ (m, 5H), 1.42-1.63 (m, 2H), 1.75-1.87 (m, 1H), 3.45 (s, 3H), 4.55 (s, 1H), 6.97 (s, 1H), 7.17-7.50 (m, 8H), 7.68 (d, $J = 7.4$ Hz, 1H); $^{13}$C NMR (CDCl$_3$, 75.4 MHz): $\delta = 22.4, 23.6, 33.4, 33.8, 49.3, 52.2, 88.9, 120.9, 124.8, 125.6, 126.9, 127.2, 127.3, 128.4, 131.7, 138.8, 144.3, 146.3, 150.1; LRMS (EI): $m/z$ (%) 290 (M$^+$, 2), 99 (100); HRMS (EI) for C$_{21}$H$_{22}$O: 290.1671; found: 290.1673.
1-(1-Hydroxycyclopentyl)-2-phenyl-1H-indene (3db).
Colourless oil; yield = 71%; R$_f$ = 0.30 (hexane:EtOAc, 5:1);
$^1$H NMR (300 MHz, CDCl$_3$): $\delta$ = 1.30-1.75 (m, 9H), 4.34 (s, 1H), 6.97 (s, 1H), 7.22 (td, $J$ = 1.4 Hz, $J$ = 7.4 Hz, 1H), 7.28-7.46 (m, 5H), 7.50-7.56 (m, 2H), 7.66 (d, $J$ = 7.5 Hz, 1H); $^{13}$C NMR (CDCl$_3$, 75.4 MHz): $\delta$ = 22.9, 23.4, 38.4, 38.7, 59.1, 83.9, 121.2, 124.6, 125.2, 127.3, 127.5, 127.9, 128.5, 131.1, 138.2, 145.0, 145.3, 150.8; LRMS (EI): m/z (%) 276 (2, M$^+$), 192 (100); HRMS (EI) for C$_{20}$H$_{20}$O: 276.1514, found: 276.1513.

1-(2-Methoxypropan-2-yl)-2-(3-thienyl)-1H-indene (3fa).
White solid; yield = 94%; R$_f$ = 0.40 (hexane:EtOAc, 10:1); m.p. = 46-47 °C; $^1$H NMR (300 MHz, CDCl$_3$): $\delta$ = 0.86 (s, 3H), 1.05 (s, 3H), 3.40 (s, 3H), 4.18 (s, 1H), 6.91 (s, 1H), 7.18-7.36 (m, 6H), 7.62 (m, 1H); $^{13}$C NMR (CDCl$_3$, 75.4 MHz): $\delta$ = 21.7, 24.8, 49.3, 58.3, 77.7, 120.6, 121.3, 124.6, 125.2, 126.1, 127.0, 127.9, 131.0, 139.7, 144.5, 145.2 (2C); LRMS (EI): m/z (%) 270 (M$^+$, 14), 197 (20), 73 (100); HRMS (EI) for C$_{17}$H$_{18}$OS: 270.1078; found: 270.1085.
1-(2-Hydroxypropan-2-yl)-2-(3-thienyl)-1H-indene (3fb).

Colourless oil; yield = 84%; \( R_f = 0.20 \) (hexane:EtOAc, 5:1); \(^1\)H NMR (300 MHz, CDCl\(_3\)): \( \delta = 0.95 \) (s, 3H), 1.29 (s, 3H), 2.00 (s, 1H), 4.07 (s, 1H), 6.94 (s, 1H), 7.20 (td, \( J = 1.2 \) Hz, \( J = 7.2 \) Hz, 1H), 7.26-7.40 (m, 5H), 7.62 (d, \( J = 7.5 \) Hz, 1H); \(^{13}\)C NMR (CDCl\(_3\), 75.4 MHz): \( \delta = 27.0, 27.6, 62.1, 73.8, 121.0, 122.2, 124.7, 125.1, 126.1, 127.2, 127.7, 130.4, 139.1, 144.7, 144.8, 145.0; \) LRMS (EI): \( m/z \) (%) 256 (3, M\(^+\)), 198 (100); HRMS (EI) for C\(_{16}\)H\(_{16}\)O: 256.0922, found: 256.0932.

2-Butyl-1-(2-methoxypropan-2-yl)-1H-indene (3ga).

Colourless oil; yield = 81%; \( R_f = 0.44 \) (hexane:EtOAc, 10:1); \(^1\)H NMR (300 MHz, CDCl\(_3\)): \( \delta = 0.96 \) (s, 3H), 0.98 (t, \( J = 7.3 \) Hz, 3H), 1.35 (s, 3H), 1.36-1.49 (m, 2H), 1.56-1.72 (m, 2H), 2.45-2.67 (m, 2H), 3.42 (s, 3H), 3.66 (s, 1H), 6.55 (s, 1H), 7.04-7.12 (m, 1H), 7.20-7.28 (m, 2H), 7.48 (d, \( J = 7.8 \) Hz, 1H); \(^{13}\)C NMR (CDCl\(_3\), 75.4 MHz): \( \delta = 14.2, 22.1, 22.9, 24.5, 31.3, 31.6, 49.2, 58.0, 77.7, 119.7, 123.4, 125.1, 126.7, 127.9, 144.7, 145.7, 153.5; \) LRMS (EI): \( m/z \) (%) 244 (1, M\(^+\)), 128 (12), 73 (100); HRMS (EI) for C\(_{17}\)H\(_{24}\)O: 244.1827; found: 244.1825.
2-Butyl-1-(2-hydroxypropan-2-yl)-1H-indene (3gb). Reaction performed using [AuNTf₂(Ph₃P)] (5 mol%, 18.5 mg) as catalyst and stirred at r.t. for 14h. Colourless oil; yield = 78%; Rᵣ = 0.33 (hexane:EtOAc, 5:1); \(^1\)H NMR (300 MHz, CDCl₃): \(\delta = 0.97\) (t, \(J = 7.3\) Hz, 3H), 1.16 (s, 3H), 1.30 (s, 3H), 1.36-1.48 (m, 2H), 1.56-1.72 (m, 2H), 1.87 (s, 1H), 2.50-2.67 (m, 2H), 3.47 (s, 1H), 6.55 (s, 1H), 7.05-7.14 (m, 1H), 7.20-7.30 (m, 2H), 7.55 (d, \(J = 7.5\) Hz, 1H); \(^1^3\)C NMR (CDCl₃, 75.4 MHz): \(\delta = 14.2, 22.8, 26.6, 28.8, 31.3, 32.0, 62.2, 73.6, 119.9, 123.6, 125.0, 126.9, 128.3, 144.6, 154.6, 152.9; LRMS (EI): \(m/z\) (%) 230 (3, M⁺), 172 (48), 129 (100); HRMS (EI) for C₁₆H₂₂O: 230.1671, found: 230.1682.

6-Bromo-1-(2-methoxypropan-2-yl)-2-phenyl-1H-indene (3ha). White solid; yield = 87%; Rᵣ = 0.37 (hexane:EtOAc, 10:1); m.p. = 104-106 °C; \(^1\)H NMR (300 MHz, CDCl₃): \(\delta = 0.72\) (s, 3H), 0.96 (s, 3H), 3.36 (s, 3H), 4.26 (s, 1H), 6.80 (s, 1H), 7.18 (d, \(J = 8.0\) Hz, 1H), 7.27-7.39 (m, 6H), 7.76 (bs, 1H); \(^1^3\)C NMR (CDCl₃, 75.4 MHz): \(\delta = 20.9, 25.5, 49.1, 57.4, 77.5, 118.7, 121.6, 127.2, 127.6, 128.2, 129.3, 129.8, 130.7, 138.2, 143.3, 147.5, 150.8; LRMS (EI): \(m/z\) (%) 342 (<5, M⁺), 189 (12), 73 (100); HRMS (EI) for C₁₉H₁₉BrO: 342.0619, found: 282.0617.
6-Bromo-1-(2-hydroxypropan-2-yl)-2-phenyl-1H-indene (3hb).

Colourless oil; yield = 73%; Rf = 0.17 (hexane:EtOAc, 10:1); \(^1\)H NMR (300 MHz, CDCl\(_3\)): \(\delta = 0.94\) (s, 3H), 1.13 (s, 3H), 1.65 (s, 1H), 4.16 (s, 1H), 6.86 (s, 1H), 7.21 (d, J = 8.0 Hz, 1H), 7.34-7.46 (m, 6H), 7.80 (bs, 1H); \(^{13}\)C NMR (CDCl\(_3\), 75.4 MHz): \(\delta = 26.8, 28.2, 61.3, 73.8, 118.7, 122.1, 127.8, 127.9, 128.6, 128.7, 130.2, 130.3, 137.5, 143.6, 147.2, 150.9\); LRMS (EI): m/z (%) 328 (M\(^+\), 270 (63), 191 (100); HRMS (EI) for C\(_{18}\)H\(_{17}\)BrO: 328.0463, found: 328.0463.

**General procedure for the gold(I)-catalyzed enantioselective synthesis of 1H-indenes 2:** AgOTs (10 mol%, 8.4 mg) was added to a solution of L7(AuCl)\(_2\) (5 mol%, 17.4 mg) in dry \(\text{CH}_2\text{Cl}_2\) (0.3 mL) and the reaction mixture was stirred 5-10 minutes and cooled to −30 °C or −20 °C (see Table 2). A solution of the corresponding o-(alkynyl)styrene derivative 1 (0.3 mmol) in dry \(\text{CH}_2\text{Cl}_2\) (0.3 mL) was added and the reaction mixture was stirred until complete disappearance of starting material, as monitored by TLC or GC-MS (3-4 days). The mixture was diluted with hexanes and filtered through a pad of silica gel, the solvent was removed under reduced pressure and the crude mixture was purified by flash chromatography on silica gel using mixtures of hexane and EtOAc as eluents. The
corresponding 1H-indenes 2 were isolated in the yields and enantioselectivities reported in Table 2.

Chiral HPLC-Traces:

Column: Chiralcel-OJ. Eluent: 90/10 (Hexane/i-PrOH). Flow: 1.0 mLmin⁻¹
Column: Chiralcel-OJ. Eluent: 90/10 (Hexane/i-PrOH). Flow: 1.0 mLmin$^{-1}$
Column: Chirapack-AD-H. Eluent: 98/2 (Hexane/i-PrOH).
Flow: 0.5 mLmin\(^{-1}\)
Column: Chiralcel-OJ. Eluent: 99/1 (Hexane/i-PrOH). Flow: 1.0 mL min⁻¹
Column: Chiralpack-AD-H. Eluent: 99/1 (Hexane/i-PrOH). Flow: 0.5 mLmin$^{-1}$
92% ee (after crystallization)

Column: Chiralpack-AD-H. Eluent: 99/1 (Hexane/i-PrOH).
Flow: 0.5 mLmin⁻¹
Column: Chiralpack-AD-H. Eluent: 99/1 (Hexane/i-PrOH).
Flow: 0.5 mL/min⁻¹
Column: Chiralcel-OD-H. Eluent: 99.5/0.5 (Hexane/i-PrOH).
Flow: 0.5 mLmin$^{-1}$
General procedure for the gold(I)-catalyzed enantioselective synthesis of indenes 3: AgSbF$_6$ (10 mol%, 5.1 mg) or AgOTs (10 mol%, 8.4 mg) was added to a solution of L7(AuCl)$_2$ (5 mol%, 17.4 mg) in dry CH$_2$Cl$_2$ (0.6 mL) and the reaction mixture was stirred 5-10 minutes and cooled to −30°C or −20°C (see Table 5 for the suitable Ag salt and temperature for each substrate). The appropriate nucleophile (30 equiv., 9 mmol) was added, followed by a solution of the corresponding o-alkynyl styrene derivative 1 (0.3 mmol) in dry CH$_2$Cl$_2$ (0.6 mL). The resulting reaction mixture was stirred at the temperature indicated in Table 3 until complete disappearance of the starting material was observed by TLC or GC-MS (2-4 days). The mixture was diluted with hexanes and filtered through a pad of silica gel, the solvent was removed under reduced pressure and the crude mixture was purified by flash chromatography on silica gel using mixtures of hexane and EtOAc as eluents. The corresponding 1H-indenes 3 were isolated in the yields and enantioselectivities reported in Table 3.
Chiral HPLC-Traces:

Column: Chiralpack-AD-H. Eluent: 99.2/0.8 (Hexane/i-PrOH).
Flow: 0.5 mLmin\(^{-1}\)
Column: Chiralpack-AD-H. Eluent: 99.2/0.8 (Hexane/i-PrOH).
Flow: 0.5 mL/min$^{-1}$
Column: Chiralpack-AD-H. Eluent: 99/1 (Hexane/i-PrOH).
Flow: 0.5 mLmin⁻¹
Column: Chiralpack-AD-H. Eluent: 99/1 (Hexane/i-PrOH).
Flow: 0.5 mLmin⁻¹
Column: Chiralpack-AD-H. Eluent: 99/1 (Hexane/i-PrOH).
Flow: 0.5 mLmin$^{-1}$
Column: Chiralpack-AD-H. Eluent: 99.2/0.8 (Hexane/i-PrOH).
Flow: 0.5 mLmin\(^{-1}\)
98% ee (after crystallization)

Column: Chiralpack-AD-H. Eluent: 99.2/0.8 (Hexane/i-PrOH).
Flow: 0.5 mLmin$^{-1}$
Column: Chiralpack-AD-H. Eluent: 99/1 (Hexane/i-PrOH). Flow: 0.5 mLmin$^{-1}$
Column: Chiralpack-AD-H. Eluent: 99/1 (Hexane/i-PrOH).
Flow: 0.5 mL min⁻¹

>98% ee (after crystallization)
Column: Chiralpack-AD-H. Eluent: 99/1 (Hexane/i-PrOH).
Flow: 0.5 mLmin$^{-1}$
Column: Chiralpack-AD-H. Eluent: 98/2 (Hexane/i-PrOH).
Flow: 0.5 mLmin⁻¹
>98% ee (after crystallization)

Column: Chiralpack-AD-H. Eluent: 98/2 (Hexane/i-PrOH).
Flow: 0.5 mLmin$^{-1}$
Column: Chiralpack-AD-H. Eluent: 70/30 (Hexane/i-PrOH).
Flow: 0.5 mLmin$^{-1}$
Column: Chiralpack-AD-H. Eluent: 70/30 (Hexane/i-PrOH).
Flow: 0.5 mLmin$^{-1}$
Column: Chiralpack-AD-H. Eluent: 99.2/0.8 (Hexane/i-PrOH).
Flow: 0.5 mLmin$^{-1}$
Column: Chiralpack-AD-H. Eluent: 90/10 (Hexane/i-PrOH).
Flow: 0.5 mL/min$^{-1}$
Column: Chiralpack-AD-H. Eluent: 99/1 (Hexane/i-PrOH).
Flow: 0.5 mLmin⁻¹
Column: Chiralpack-AD-H. Eluent: 99/1 (Hexane/i-PrOH). Flow: 0.5 mLmin$^{-1}$
Column: Chiralpack-AD-H. Eluent: 90/10 (Hexane/i-PrOH).
Flow: 0.5 mL min\(^{-1}\)
Column: Chiralpack-AD-H. Eluent: 90/10 (Hexane/i-PrOH).
Flow: 0.5 mL min$^{-1}$
Column: Chiralcel-OD-H. Eluent: 99/1 (Hexane/i-PrOH). Flow: 1.0 mLmin$^{-1}$
Column: Chiralcel-OD-H. Eluent: 99/1 (Hexane/i-PrOH). Flow: 1.0 mLmin$^{-1}$
Column: Chiralpack-AD-H. Eluent: 99/1 (Hexane/i-PrOH).
Flow: 0.5 mLmin⁻¹

3ha (80% ee)
>98% ee (after crystallization)

Column: Chiralpack-AD-H. Eluent: 99/1 (Hexane/i-PrOH).
Flow: 0.5 mL/min⁻¹
Column: Chiralpack-AD-H. Eluent: 93/7 (Hexane/i-PrOH). Flow: 0.5 mL min$^{-1}$
Column: Chiralpack-AD-H. Eluent: 93/7 (Hexane/i-PrOH).
Flow: 0.5 mL/min⁻¹
X-RAY STRUCTURE OF COMPOUND 3ha
$^1$H and $^{13}$C NMR
3ab
3ad