Supporting Information

Ru(dppbsa)-catalyzed hydrodeoxygenation and reductive etherification of ketones and aldehydes

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1. General experimental information

Unless specified, all substrates (aldehydes and ketones), Ru precursor was obtained commercially and their purity has been checked before use. All reactions were done under argon using a standard glove box and the solvents were dried before use unless otherwise noted. In particular, the Schlenk techniques were used in the synthesis of the Ru catalyst. All catalytic reactions were carried out in 25 mL autoclaves (Wuzhou Dingchuang (Beijing) Technology Co., Ltd.). GC-7890B equipped with a capillary column (DB-FFAP, 30 m × 0.32 mm) using a flame ionization detector. GC-MS was performed using Shimadzu GCMS-QP2020, column Rtx-5MS 30 m × 0.25 mm × 0.25 μm. GC was recorded on an Agilent 8890N instrument. $^1$H, $^{13}$C, $^{31}$P NMR data were recorded on a Bruker ASCEND spectrometer ($^1$H, 600 MHz; $^{13}$C($^1$H), 151 MHz) using CDCl₃ or CD₃OD as solvents. $^1$H NMR and $^{13}$C NMR, chemical shift δ is given relative to TMS and referenced to the solvent signal. Chemical shifts were reported in ppm with the internal TMS signal at 0.0 ppm as a standard. The spectra are interpreted as: s = singlet, d = doublet, t = triplet, m = multiplet, dd = doublet of doublets, dt = doublet of triplets, ddd = doublet of doublet of doublets, coupling constant (s) J are reported in Hz and relative integrations are reported. Column chromatography was performed using silica gel. Analytical TLC was done using pre-coated silica gel 60 F254 plates.
2. Preparation and characterization of Ru(dppbsa)

*Preparation of dppbsa Ligand*

According to the literature, benzenesulfonic acid (0.80 g, 5 mmol) was dissolved in a Schleck tube with 25 mL of THF, n-BuLi (2.5 M in hexanes; 4 mL, 10 mmol) was added at 0 °C. After stirring for 1 h at room temperature; the solution was cooled to 0 °C again, a solution of chlorodi-phenylphosphane (1.10 g, 5 mmol) in THF (10 mL) was added dropwise to the Schleck tube and stirred at room temperature overnight. After the reaction, the solvent was removed in vacuo to obtain a pale-yellow solid. The solid was dissolved in dichloromethane (50 mL) and extracted with aqueous HCl (2 M, 30 mL), and then deionized water (30 mL) was added twice. The crude product was dissolved in dichloromethane and recrystallized with ether at -32 °C to obtain 1.05 g of white solid with a yield of 62%. $^1$H NMR (600 MHz, 298K, CDCl₃): δ = 8.39 (m, 1H), 7.80 (m, 1H), 7.73 (m, 2H), 7.66 (m, 2H), 7.64 (m, 2H), 7.59 (m, 4H), 7.49 (m, 1H), 7.25 (m, 1H), N.O. (-SO₃H). $^{13}$C{$^1$H} NMR (151 MHz, 298K, CDCl₃): δ = 152.9 (JPC = 8.9 Hz, i-Ph-SO₃H), 135.5 (JPC = 3.2 Hz, i-Ph), 134.6 (JPC = 3.0 Hz, 2 × i-Ph), 134.5, 134.4, 134.0, 133.9, 130.2, 130.1 (4), 130.1 (1), 130.0 (5), 129.4 (2), 129.3 (6), 119.1, 118.5, 113.7, 113.1 (Ph). $^{31}$P{$^1$H} NMR (243 MHz, 298K, CDCl₃): δ = 3.8.

$^1$H NMR (600 MHz, CDCl₃, 298 K) of dppbsa
$^{13}$C NMR (151 MHz, CDCl$_3$, 298 K) of dppbsa

$^{31}$P NMR (243 MHz, CDCl$_3$, 298 K) of dppbsa
Preparation of Ru(dppbsa) Complex

According to the literature, \( \text{S}_2 \) dppbsa ligand (164.2 mg, 0.46 mmol) and t-BuOK (58.2 mg, 0.51 mmol, 1.1 equiv.) were added to a 25 mL Schlenk tube, 10 mL of degassed MeOH was added, and the mixture was stirred at room temperature for 30 min; \([\text{Ru}(\rho\text{-cymene})\text{Cl}_2]\) (144.5 mg, 0.22 mmol, 0.5 equiv.) was added and stirred at room temperature for 16 h; after the MeOH was removed in vacuo, the solid was dissolved in dichloromethane. Filter and recrystallize in n-hexane/dichloromethane solution to obtain 262.2 mg of dark red solid, with a yield of 90%. \(^1\)H NMR (600 MHz, 298 K, CDCl\textsubscript{3}): \( \delta = 8.08 \) (m, 1H), 7.92 (m, 2H), 7.64 (m, 1H), 7.62 (m, 1H), 7.54 (m, 1H), 7.50 (m, 1H), 7.46 (m, 4H), 7.44 (m, 1H), 7.25 (m, 1H), 6.96 (m, 1H), 5.83 (d, \(^3\)J\text{HH} = 6.5 Hz, 1H), 5.78 (d, \(^3\)J\text{HH} = 6.5 Hz, 1H), 5.54 (d, \(^3\)J\text{HH} = 5.5 Hz, 1H), 5.44 (d, \(^3\)J\text{HH} = 5.5 Hz, 1H), 2.62 (sept, \(^3\)J\text{HH} = 6.8 Hz, \(^3\)J\text{HH} = 6.8 Hz, 1H), 1.89 (s, 3H, CH\textsubscript{3}), 1.15 (d, \(^3\)J\text{HH} = 6.8 Hz, 3H), 0.94 (d, \(^3\)J\text{HH} = 6.8 Hz, 3H). \(^{13}\)C\text{\textsuperscript{1}H} NMR (151 MHz, 298K, CDCl\textsubscript{3}): \( \delta = 147.2 \) (\( \text{J}_{\text{PC}} = 12.8 \) Hz, \( \text{i-Ph-SO}_3\text{Ru} \)), 136.1 (\( \text{J}_{\text{PC}} = 9.8 \) Hz), 134.1 (\( \text{J}_{\text{PC}} = 9.8 \) Hz), 133.3, 133.0(0), 132.9(6), 131.8 (\( \text{J}_{\text{PC}} = 2.5 \) Hz), 131.5, 131.3 (\( \text{J}_{\text{PC}} = 2.0 \) Hz), 131.2, 131.0 (\( \text{J}_{\text{PC}} = 2.5 \) Hz), 129.9 (\( \text{J}_{\text{PC}} = 6.8 \) Hz), 128.7 (\( \text{J}_{\text{PC}} = 8.3 \) Hz), 128.5 (\( \text{J}_{\text{PC}} = 9.7 \) Hz), 128.4 (\( \text{J}_{\text{PC}} = 10.3 \) Hz), 128.2, 128.1, 108.0, 94.4, 92.9 (\( \text{J}_{\text{PC}} = 5.3 \) Hz), 87.3 (\( \text{J}_{\text{PC}} = 7.7 \) Hz), 85.6 (\( \text{J}_{\text{PC}} = 2.2 \) Hz), 83.9 (\( \text{J}_{\text{PC}} = 2.2 \) Hz), 30.2, 22.9, 20.5, 17.8. \(^{31}\)P\text{\textsuperscript{1}H} NMR (243 MHz, 298K, CDCl\textsubscript{3}): \( \delta = 22.9. \)
$^1$H NMR (600 MHz, CDCl$_3$, 298 K) of Ru(dppbsa)

$^{13}$C NMR (151 MHz, CDCl$_3$, 298 K) of Ru(dppbsa)

$^{31}$P NMR (243 MHz, CDCl$_3$, 298 K) of Ru(dppbsa)
3. **Ruthenium-catalyzed deoxygenation and etherification reactions**

**General Procedure:** In a typical experiment, combination of substrate (0.2 mmol), Ru(dppbsa) (6.1 mg, 10 μmol) and p-TsOH (3.4 mg, 20 μmol) was dissolved in toluene (2 mL) in a reaction vessel equipped with a Teflon lining and a stir bar in the glove box. After addition of the above reactants, the reaction vessel was filled with H\textsubscript{2} (3 MPa). The solution was stirred at 150 °C. At the end of the reaction, the pressure of reaction vessel was gradually released, and the reaction mixture was diluted with ethyl acetate (20 mL) for analysis. The structures of the products were determined by GC-MS analysis, and yields determined by GC analysis. For some selected examples, the solvent was removed under vacuum to provide a crude product for \textsuperscript{1}H NMR (600 MHz, 298 K, CDCl\textsubscript{3}) analysis. The structures of the products were determined by \textsuperscript{1}H NMR and \textsuperscript{13}C NMR, with spectra matching those reported in the literature or authentic samples.
### Screening Conditions for Catalytic Hydrogenation of Acetophenone (1a).

**Table S1:** Ru(dppbsa)-catalyzed hydrogenation of acetophenone (1a).

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<th>Ru(dppbsa) (mol %)</th>
<th>Temp. (°C)</th>
<th>P-TsOH (mol %)</th>
<th>H₂ (MPa)</th>
<th>solvent</th>
<th>Conv. (%)</th>
<th>Yield (%)</th>
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<th>3a</th>
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ᵃ General conditions: 1a (0.2 mmol), 20 h, under argon, in autoclave; yields determined by GC wherein biphenyl was used as internal standard;ᵇ 46% of 5aa were found in the product;ᶜ Reaction time was 8 h;ᵈ Reaction time was 12 h;ᵉ Reaction time was 16 h;ᶠ AgBF₄ (10 mol %);ᵍ AlCl₃ (10 mol %);ʰ dppbsa (5 mol %);¹ [Ru(p-cymene)Cl₂]₂ (2.5 mol %).
**Screening Conditions for Catalytic Etherification of Acetophenone (1a).**

Table S2. Catalytic etherification of acetophenone (1a) with i-PrOH (8a) in the presence of Ru(dppbsa)\(^a\)

![Chemical reaction diagram]

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<th>[Ru] (mol %)</th>
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<th>(H_2) (MPa)</th>
<th>Conv.</th>
<th>Yield (%)(^a)</th>
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\(^a\) General conditions: 1a (0.2 mmol), 8a (1 mL), toluene (1 mL), 20 h, under argon, in autoclave; yields determined by GC.
**Screening Conditions for Catalytic Etherification of Benzaldehyde (6a).**

**Table S3.** Catalytic etherification of benzaldehyde (6a) with alcohols (8) in the presence of Ru(dppbsa) complex

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a General conditions: 6a (0.2 mmol), 8 (1 mL), toluene (1 mL), 20 h, under argon, in autoclave; yields determined by GC; b 8a (10 equiv.).

4. Hydrodeoxygenation of aldehydes in toluene

**Scheme S1** Hydrodeoxygenation of aldehydes in toluene
5. Hydrodeoxygenation of 1a/3a/4a with D₂

Ru(dppbsa) (5 mol %), p-TsOH (10 mol %) were dissolved with toluene (2 mL) in a reaction vessel equipped with a Teflon lining and a stir bar. After 1a/3a/4a (0.2 mmol) was added, the reaction vessel was filled with D₂ (3 MPa). The mixture was stirred at 150 °C for 20 h. Thereafter, the pressure of reaction vessel was gradually released, and the reaction solution was diluted with ethyl acetate (20 mL) for analysis. The distribution of the product was determined by GC analysis.

$^2$H NMR and $^1$H NMR (600 MHz, CDCl₃, 298 K) of product of 1j with D₂
$^2$H NMR and $^1$H NMR (600 MHz, CDCl$_3$, 298 K) of product of 3j with D$_2$

$^2$H NMR and $^1$H NMR (600 MHz, CDCl$_3$, 298 K) of product of 4j with D$_2$
6. Hammett study

The reactions were performed in parallel reaction vessel for designated time on multi-zone reaction platform. In a glove box, Ru(dppbsa) (5 mol %), p-TsOH (10 mol %) were dissolved with solvent (2 mL) in a reaction vessel equipped with a Teflon lining and a stir bar. After $p$-$Y$-acetophenone or $p$-$Y$-benzaldehyde ($Y$ = OMe, Me, H, Cl, CF$_3$) was added, the reaction vessel was filled with H$_2$ (3 MPa). The mixture was stirred at 150 °C for 2~4 h. Thereafter, the pressure of reaction vessel was gradually released, and the reaction solution was diluted with ethyl acetate (20 mL) for analysis. The distribution of the product was determined by GC analysis. The $k_{obsd}$ of each catalytic reaction is determined from a first-order plot of $[p$-$Y$-ethylbenzene]$_t$] (Fig. S1A) or $[(p$-$Y$-methyl benzene)]$_t$] (Fig. S1B) vs. time.

![Fig. S1 First-order plot of $[(p$-$Y$-ethylbenzene)]$_t$] (A) or $[(p$-$Y$-methyl benzene)]$_t$] (B) vs. time](image)

Fig. S2 First-order plot of $[(p$-$Y$-ethylbenzene)]$_t$] vs. time (solvent: heptane) ($Y$ = OMe, Me, H, Cl, CF$_3$)
**Fig. S3** Hammett plot of the Ru(dppbsa)-catalyzed hydrodeoxygenation of \( p \)-\( Y \)-acetophenone (solvent: heptane) \( (Y = \text{OMe, Me, H, Cl, CF}_3) \)

7. Detection of \( p \)-cymene

**Fig. S4** GC-MS analysis of \( p \)-cymene in the evaluation of catalytic performance
8. Deuterium isotope effect study

The reactions were performed in parallel reaction vessel for designated time on multi-zone reaction platform. In a glove box, Ru(dppbsa) (5 mol %), p-TsOH (10 mol %) were dissolved with toluene (2 mL) in a reaction vessel equipped with a Teflon lining and a stir bar. After 1a or 6a (0.2 mmol) was added, the reaction vessel was filled with H₂ or D₂ (3 MPa). The mixture was stirred at 150 °C for 2~4 h. Thereafter, the pressure of reaction vessel was gradually released, and the reaction solution was diluted with ethyl acetate (20 mL) for analysis. The distribution of the product was determined by GC analysis using biphenyl as an internal standard. The $k_{\text{obsd}}$ was determined from a first-order plot of $-\ln[(1a)/1a_0]$ or $-\ln[(6a)/6a_0]$ vs. time, and $k_H/k_D$ was calculated from the ratio of the slopes.

Fig. S5 First-order plot for the hydrogenolysis of 1a (solvent: heptane) with H₂ (■) and with D₂ (▲) catalyzed by Ru(dppbsa).
9. Empirical rate measurements

*Catalyst concentration dependence study.*

Ru(dppbsa) (2.5 \~ 10 mol %), p-TsOH (10 mol %) were dissolved with solvent (2 mL) in a reaction vessel equipped with a Teflon lining and a stir bar. After 1a or 10a (0.2 mmol) was added, the reaction vessel was filled with H₂ (3 MPa). The mixture was stirred at the different temperature (150 °C) for 2~4 h. Thereafter, the pressure of reaction vessel was gradually released, and the reaction solution was diluted with ethyl acetate (20 mL) for analysis. The distribution of the product was determined by GC analysis. Linear regression of the rates versus concentration of 1a or 10a indicates a first-order dependence on Ru(dppbsa) (Figures S1~S2).

![Fig. S6](image1.png) Experiments measuring the concentration of 1a or 10a with respect to time for a series of reactions at varied concentrations of Ru(dppbsa).

![Fig. S7](image2.png) Reaction rate with respect to concentration of Ru(dppbsa).
Ketone and aldehyde substrate dependence study.

Ru(dppbsa) (5 mol %), p-TsOH (10 mol %) were dissolved with solvent (2 mL) in a reaction vessel equipped with a Teflon lining and a stir bar. After a series of varying concentration of 1a or 10a was added, the reaction vessel was filled with H₂ (3 MPa). The mixture was stirred at the different temperature (150 °C) for 2~4 h. Thereafter, the pressure of reaction vessel was gradually released, and the reaction solution was diluted with ethyl acetate (20 mL) for analysis. The distribution of the product was determined by GC analysis. Linear regression of the rates versus concentration of 1a or 10a indicates a first-order dependence on the substrate (Figures S3~S4).

Fig. S8 Experiments measuring the concentration of 1a or 10a with respect to time for a series of reactions at varied concentrations of 1a or 10a.

Fig. S9 Reaction rate with respect to concentration of 1a or 10a.
**Hydrogen pressure dependence study.**

Ru(dppbsa) (5 mol %), p-TsOH (10 mol %) were dissolved with solvent (2 mL) in a reaction vessel equipped with a Teflon lining and a stir bar. After 1a or 10a (0.2 mmol) was added, the reaction vessel was filled with H₂ (1~ 5 MPa). The mixture was stirred at the different temperature (150 °C) for 2~4 h. Thereafter, the pressure of reaction vessel was gradually released, and the reaction solution was diluted with ethyl acetate (20 mL) for analysis. The distribution of the product was determined by GC analysis. Linear regression of the rates versus concentration of 1a or 10a indicates a first-order dependence on the hydrogen pressure (Figures S5~S6).

**Fig. S10** Experiments measuring the concentration of 1a or 10a with respect to time for a series of reactions at varied pressure of H₂.

**Fig. S11** Reaction rate with respect to pressure of H₂.
10. $^{31}$P NMR experiment on Ru(dppbsa) with or without 1a and $p$-TsOH

![NMR spectra](image)

Fig. S12 $^{31}$P NMR (243 MHz, $C_6D_6$, 298 K) of Rudppbsa and solution of 1a, $p$-TsOH, and Ru(dppbsa)

11. The path of keto-enol tautomerization

![Scheme S2](image)

Scheme S2 The path of keto-enol tautomerization (taking complex D as an example).
12. Proposed reaction pathway for the reductive etherification of carbonyl compounds.

![Diagram of proposed reaction pathway]

Scheme S3 Proposed reaction pathway for the reductive etherification of carbonyl compounds.

13. Etherification of 6n with i-PrOH-d7 and i-PrOH-d8

Table S4 Deuterium labeling study on the Ru(dppbsa)-catalyzed reductive etherification of aldehydes

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<td>(d_7)</td>
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\(^a\) General conditions: 6n (0.2 mmol), under argon, in autoclave; \(^b\) GC yield.
$^2$H NMR and $^1$H NMR (600 MHz, CDCl$_3$, 298 K) of 7n-d of 6n with i-PrOH-d$_7$.

$^2$H NMR and $^1$H NMR (600 MHz, CDCl$_3$, 298 K) of 9na-d of 6n with i-PrOH-d$_7$. 

S22
$^2$H NMR and $^1$H NMR (600 MHz, CDCl$_3$, 298 K) of 7n-d of 6n with i-PrOH-d$_8$

$^2$H NMR and $^1$H NMR (600 MHz, CDCl$_3$, 298 K) of 9na-d of 6n with i-PrOH-d$_8$
14. NMR, GC and GC-MS data

1. Ethylbenzene (2a)
Analytically pure product was isolated by a column chromatography on silica gel (hexanes/EtOAc = 50:1). Colorless liquid, Yield: 18.2 mg, 86%. $^1$H NMR (600 MHz, CDCl$_3$, 298 K): δ = 7.43 (t, $^3$J$_{HH}$ = 7.5 Hz, 2H, Ph), 7.33 (m, 3H, Ph), 2.81 (q, $^3$J$_{HH}$ = 7.7 Hz, 2H, CH$_2$), 1.41 (t, $^3$J$_{HH}$ = 7.7 Hz, 3H, CH$_3$). $^{13}$C{$^1$H} NMR (151 MHz, CDCl$_3$, 298 K): δ = 143.2, 127.3 (2C), 126.8 (2C), 124.5, 27.9, 14.6.

GC: 2a: 3.979 min. Biphenyl: 8.858 min. GC-MS (m/z): Calcd. 106; Found 106.

2. 1-Ethyl-4-Methoxybenzene (2b)
Analytically pure product was isolated by a column chromatography on silica gel (hexanes/EtOAc = 50:1). Colorless liquid, Yield: 24.5 mg, 90%. $^1$H NMR (600 MHz, CDCl$_3$, 298 K): δ = 7.12 (d, $^3$J$_{HH}$ = 7.1 Hz, 2H, Ph), 6.83 (d, $^3$J$_{HH}$ = 6.8 Hz, 2H, Ph), 3.79 (s, 3H, CH$_3$), 2.56 (q, $^3$J$_{HH}$ = 7.6 Hz, 2H, CH$_2$), 1.21 (t, $^3$J$_{HH}$ = 7.7 Hz, 3H, CH$_3$). $^{13}$C{$^1$H} NMR (151 MHz, CDCl$_3$, 298 K): δ = 157.6, 136.4, 128.7 (2C), 113.7 (2C), 55.3, 27.9, 15.9.

GC: 2b: 6.689 min. GC-MS (m/z): Calcd. 136; Found 136.

3. 1-Ethyl-4-Methylbenzene (2c)
Analytically pure product was isolated by a column chromatography on silica gel (hexanes/EtOAc = 50:1). Colorless liquid, Yield: 21.1 mg, 88%. $^1$H NMR (600 MHz, CDCl$_3$, 298 K): δ = 7.11 (s, 4H, Ph), 2.63 (q, $^3$J$_{HH}$ = 7.6 Hz, 2H, CH$_2$), 2.33 (s, 3H, CH$_3$). $^{13}$C{$^1$H} NMR (151 MHz, CDCl$_3$, 298 K): δ = 141.2, 135.0, 129.0 (2C), 127.7 (2C), 28.4, 20.9, 15.7.

GC: 2c: 4.725 min. GC-MS (m/z): Calcd. 120; Found 120.

4. 4-Ethyl-1,1'-Biphenyl (2d)
Analytically pure product was isolated by a column chromatography on silica gel (hexanes/EtOAc = 50:1). Colorless liquid, Yield: 32.0 mg, 88%. $^1$H NMR (600 MHz, CDCl$_3$, 298 K): δ = 7.59 (dd, $^3$J$_{HH}$ = 8.4 Hz, 2H, Ph), 7.53 (dt, $^3$J$_{HH}$ = 8.4 Hz, 2H, Ph), 7.43 (t, $^3$J$_{HH}$
hexanes/EtOAc = 50:1). Colorless liquid, Yield: 24. Analytically pure product was isolated by a column chromatography on silica gel (hexanes/EtOAc = 50:1). Colorless liquid, Yield: 22. GC: 3f: 9.670 min. GC-MS (m/z): Calcd. 182; Found 182.

5. **1-Ethyl-4-Fluorobenzene (2e)**

Analytically pure product was isolated by a column chromatography on silica gel (hexanes/EtOAc = 50:1). Colorless liquid, Yield: 24. GC: 2e: 4.315 min. GC-MS (m/z): Calcd. 124; Found 124.

6. **1-Ethyl-4-Chlorobenzene (2f)**

Analytically pure product was isolated by a column chromatography on silica gel (hexanes/EtOAc = 50:1). Colorless liquid, Yield: 24. GC: 2f: 5.988 min. GC-MS (m/z): Calcd. 140; Found 140.

7. **1-Ethyl-4-Bromobenzene (2g)**

Analytically pure product was isolated by a column chromatography on silica gel (hexanes/EtOAc = 50:1). Colorless liquid, Yield: 24. GC: 2g: 6.766 min. GC-MS (m/z): Calcd. 185; Found 185.

8. **1-Ethyl-4-Iodobenzene (2h)**

Analytically pure product was isolated by a column chromatography on silica gel (hexanes/EtOAc = 50:1). Colorless liquid, Yield: 24. GC: 2h: 6.766 min. GC-MS (m/z): Calcd. 185; Found 185.
CH3, 1.21 (t, 3JHH = 7.4 Hz, 3H, CH3). 13C{1H} NMR (151 MHz, CDCl3, 298 K): δ = 143.8, 137.3 (2C), 130.0 (2C), 90.5, 28.4, 15.4.

GC: 2h: 7.652 min. GC-MS (m/z): Calcd. 232; Found 232.

9. 1-Ethyl-4-(Trifluoromethyl)benzene (2i)
GC: 2i: 4.175 min. GC-MS (m/z): Calcd. 174; Found 174.

10. 2-Ethynaphthalene (2j)
Analytically pure product was isolated by a column chromatography on silica gel (hexanes/EtOAc = 100:1). Colorless liquid, Yield: 27.7 mg, 89%. 1H NMR (600 MHz, CDCl3, 298 K): δ = 7.77 (m, 3H, Ph), 7.62 (s, 1H, Ph), 7.38 (m, 2H, Ph), 7.34 (dd, 3JHH = 8.4, 1.6 Hz, 1H, Ph), 2.81 (q, 3JHH = 7.9 Hz, 2H, CH2), 1.32 (t, 3JHH = 7.7 Hz, 3H, CH3).
13C{1H} NMR (151 MHz, CDCl3, 298 K): δ = 141.7, 133.7, 131.9, 127.8, 127.6, 127.4, 127.1, 125.8, 125.5, 125.0, 29.0, 15.5.
GC: 2j: 8.692 min. GC-MS (m/z): Calcd. 156; Found 156.

11. 1-Ethyl-3-Methylbenzene (2k)
Analytically pure product was isolated by a column chromatography on silica gel (hexanes/EtOAc = 50:1). Colorless liquid, Yield: 20.4 mg, 85%. 1H NMR (600 MHz, CDCl3, 298 K): δ = 7.18 (m, 3H, Ph), 7.13 (m, 1H, Ph), 2.67 (q, 3JHH = 7.5 Hz, 2H, CH2), 2.34 (s, 3H, CH3), 1.25 (t, 3JHH = 7.7 Hz, 3H, CH3). 13C{1H} NMR (151 MHz, CDCl3, 298 K): δ = 142.3, 135.7 130.0, 127.9, 126.0, 125.7, 26.2, 19.1, 14.4.
GC: 2k: 4.745 min. GC-MS (m/z): Calcd. 120; Found 120.

12. 1-Ethyl-2-Methylbenzene (2l)
GC: 2l: 6.023 min. GC-MS (m/z): Calcd. 120; Found 120.

13. n-Propylbenzene (2m)
14. Diphenylmethylene (2n)
Analytically pure product was isolated by a column chromatography on silica gel (hexanes/EtOAc = 100:1). Colorless liquid, Yield: 5.7 mg, 17%. $^1$H NMR (600 MHz, CDCl$_3$, 298 K): $\delta = 7.29$ (m, 4H, Ph), 7.21 (m, 6H, Ph), 3.99 (s, 2H, CH$_2$). $^{13}$C($^1$H) NMR (151 MHz, CDCl$_3$, 298 K): $\delta = 141.1$ (2C), 128.9 (4C), 128.4 (4C), 126.0 (2C), 41.9.
GC: 2n: 8.938 min. GC-MS (m/z): Calcd. 168; Found 168.

15. 10,11-Dihydro-5H-Dibenzo[a,d]cycloheptene (2o)
Analytically pure product was isolated by a column chromatography on silica gel (hexanes/EtOAc = 20:1). White solid, Yield: 7.7 mg, 20%. $^1$H NMR (600 MHz, CDCl$_3$, 298 K): $\delta = 7.30$ (m, 1H, Ph), 7.20 (dd, $^3$J$_{HH} = 7.3$ Hz, 2H, Ph), 7.12 (m, 5H, Ph), 4.13 (s, 2H, CH$_2$), 3.19 (s, 4H, CH$_2$). $^{13}$C($^1$H) NMR (151 MHz, CDCl$_3$, 298 K): $\delta = 139.3$ (2C), 138.9 (2C), 129.6 (2C), 129.0 (2C), 126.6 (2C), 126.1 (2C), 41.0, 32.5 (2C).
GC: 2o: 11.071 min. GC-MS (m/z): Calcd. 194; Found 194.

16. 9H-Xanthene (2p)
Analytically pure product was isolated by a column chromatography on silica gel (hexanes/EtOAc = 20:1). White solid, Yield: 2.9 mg, 8%. $^1$H NMR (600 MHz, CDCl$_3$, 298 K): $\delta = 7.17$ (q, $^3$J$_{HH} = 8.0$ Hz, 4H, Ph), 7.02 (q, $^3$J$_{HH} = 8.5$ Hz, 4H, Ph), 4.06 (s, 2H, CH$_2$).
$^{13}$C($^1$H) NMR (151 MHz, CDCl$_3$, 298 K): $\delta = 150.9$, 127.8 (2C), 126.6 (2C), 121.9 (2C), 119.5, 115.4 (2C), 28.6, 26.9 (2C).
GC: 2p: 10.574 min. GC-MS (m/z): Calcd. 182; Found 182.

17. 1,3-Diphenylpropane (2q)
GC: 2q: 9.021 min. GC-MS (m/z): Calcd. 196; Found 196.
18. 2-Ethylthiophene (2r)
GC: 2r: 4.347 min. GC-MS (m/z): Calcd. 114; Found 114.

19. Cyclohexane (2s)
GC: 2s: 1.657 min. GC-MS (m/z): Calcd. 84; Found 84.

20. n-Butylbenzene (2t)
GC: 2t: 5.385 min. GC-MS (m/z): Calcd. 134; Found 134.

21. Flavan (2u)
Analytically pure product was isolated by a column chromatography on silica gel (hexanes/EtOAc = 10:1). Yellow solid, Yield: 33.1 mg, 79%. $^1$H NMR (600 MHz, CDCl$_3$, 298 K): $\delta = 7.98$ (dd, $^3J_{HH} = 8.1$, 1.3 Hz, 2H, Ph), 7.89 (s, 1H, Ph), 7.57 (t, $^3J_{HH} = 7.5$ Hz, 1H, Ph), 7.45 (t, $^3J_{HH} = 7.9$ Hz, 2H, Ph), 7.11 (m, 2H, Ph), 6.91 (d, $^3J_{HH} = 8.0$ Hz, 1H, Ph), 6.85 (td, $^3J_{HH} = 7.4$, 1.0 Hz, 1H, CH), 3.45 (t, $^3J_{HH} = 6.1$ Hz, 2H, CH$_2$), 3.04 (t, $^3J_{HH} = 6.3$ Hz, 2H, CH$_2$). $^{13}$C($^1$H) NMR (151 MHz, CDCl$_3$, 298 K): $\delta = 202.0$, 154.5, 136.1, 133.8, 130.6, 128.7 (2C), 128.3 (2C), 128.0, 127.7, 120.7, 117.5, 40.4, 23.4.
GC: 2u: 11.485 min. GC-MS (m/z): Calcd. 210; Found 210.

22. 1, 3, 5 (10)-estratrien-3-ol (2v)
Analytically pure product was isolated by a column chromatography on silica gel (CH$_2$Cl$_2$/MeOH = 10:1). White solid, Yield: 16.9 mg, 33%. $^1$H NMR (600 MHz, CDCl$_3$, 298 K): $\delta = 7.14$ (d, $^3J_{HH} = 8.4$ Hz, 1H, Ph), 6.62 (dd, $^3J_{HH} = 8.5$, 2.6 Hz, 1H, Ph), 6.55 (d, $^3J_{HH} = 2.7$ Hz, 1H, Ph), 4.68 (t, $^3J_{HH} = 8.5$ Hz, 1H, Cy), 2.81 (m, 2H, Cy), 2.26
(m, 1H, Cy), 2.19 (m, 1H, Cy), 2.05 (s, 2H, Cy), 1.87 (m, 2H, Cy), 1.73 (m, 1H, Cy), 1.54 (s, 2H, Cy), 1.25 (s, 6H, CH₂), 0.82 (s, 3H, CH₃). $^{13}$C{¹H} NMR (151 MHz, CDCl₃, 298 K): $\delta$ = 152.0, 136.9, 129.1, 124.1, 113.8, 111.9, 109.2, 52.6, 42.0, 41.9, 37.9, 37.8, 34.5, 30.1, 28.6, 27.3, 21.3, 13.1.

23. Pregn-4-en-20-one and Pregn-5-en-20-one (2w)

Analytically pure product was isolated by a column chromatography on silica gel (CH₂Cl₂/MeOH = 10:1). White solid, Yield: 28.7 mg, 48% (isomers were not separated). $^1$H NMR (600 MHz, CDCl₃, 298 K): $\delta$ = 5.28 (br s, 1H), 5.24 (d, 1H), 2.51 (q, $^3$JHH = 9.1 Hz, 2H), 2.12 - 2.23 (m, 4H), 2.10 (s, 2H), 2.11 (d, $^3$JHH = 2.6 Hz, 4H), 0.93 - 2.07 (m, 40 H), 0.90 (m, 3H), 0.76 (s, 3H), 0.6 (m, 6H). $^{13}$C{¹H} NMR (151 MHz, CDCl₃, 298 K): $\delta$ = 209.6, 209.6, 144.5, 143.5, 119.2, 118.6, 63.9, 63.8, 56.8, 56.7, 54.5, 46.9, 44.3, 43.5, 40.4, 39.3, 39.1, 38.6, 37.5, 36.2, 35.8, 35.4, 32.0, 28.9, 28.8, 27.3, 27.1, 26.9, 26.7, 26.5, 24.4, 24.3, 24.1, 22.8, 22.6, 22.1, 21.2, 20.7, 20.75, 13.4, 13.36, 12.1. $^1$H and $^{13}$C NMR spectral data are in good agreement with the literature data.

24. Toluene (7a)

Analytically pure product was isolated by a column chromatography on silica gel (hexanes/EtOAc = 50:1). White solid, Yield: 14.7 mg, 80%. $^1$H NMR (600 MHz, CDCl₃, 298 K): $\delta$ = 7.28 (t, $^3$JHH = 7.4 Hz, 2H, Ph), 7.19 (m, 3H, Ph), 2.38 (s, 3H, CH₃). $^{13}$C{¹H} NMR (151 MHz, CDCl₃, 298 K): $\delta$ = 137.9, 129.0 (2C), 128.2 (2C), 125.3, 21.4. GC: 7a: 3.210 min. GC-MS (m/z): Calcd. 92; Found 92.

25. 4,N,N-Trimethylaniline (7b)

Analytically pure product was isolated by a column chromatography on silica gel (hexanes/EtOAc = 50:1). Light yellow liquid, Yield: 17.8 mg, 66%. $^1$H NMR (600 MHz, CDCl₃, 298 K): $\delta$ = 7.07 (dd, $^3$JHH = 8.1 Hz, 2H, Ph), 6.71 (dd, $^3$JHH = 8.1 Hz, 2H, Ph), 2.91 (s, 6H, CH₃), 2.27 (s, 3H, CH₃). $^{13}$C{¹H} NMR (151 MHz, CDCl₃, 298 K): $\delta$ = 148.7, 129.6 (4C), 113.3, 41.1, 20.2 (2C). GC: 7b: 7.167 min. GC-MS (m/z): Calcd. 135; Found 135.
26. 1-Methoxy-4-Methylbenzene (7c)
GC: 7c: 6.204 min. GC-MS (m/z): Calcd. 122; Found 122.

27. p-Xylene (7d)
Analytically pure product was isolated by a column chromatography on silica gel (hexanes/EtOAc = 50:1). Colorless liquid, Yield: 16.7 mg, 79%. \(^1\)H NMR (600 MHz, CDCl\(_3\), 298 K): \(\delta = 7.12\) (s, 4H, Ph), 2.37 (s, 6H, CH\(_3\)). \(^{13}\)C\(^{1}\)H NMR (151 MHz, CDCl\(_3\), 298 K): \(\delta = 134.7\) (2C), 128.9 (4C), 21.0 (2C).
GC: 7d: 4.024 min. GC-MS (m/z): Calcd. 106; Found 106.

28. 4-Phenyltoluene (7e)
Analytically pure product was isolated by a column chromatography on silica gel (hexanes/EtOAc = 100:1). Colorless liquid, Yield: 26.9 mg, 80%. \(^1\)H NMR (600 MHz, CDCl\(_3\), 298 K): \(\delta = 7.58\) (d, \(3J_{HH} = 7.9\) Hz, 2H, Ph), 7.49 (d, \(3J_{HH} = 7.5\) Hz, 2H, Ph), 7.42 (t, \(3J_{HH} = 7.5\) Hz, 2H, Ph), 7.32 (t, \(3J_{HH} = 7.4\) Hz, 2H, Ph), 7.25 (m, 2H, Ph), 2.40 (s, 3H, CH\(_3\)). \(^{13}\)C\(^{1}\)H NMR (151 MHz, CDCl\(_3\), 298 K): \(\delta = 141.1, 138.3, 137.0, 129.4\) (2C), 128.7 (2C), 127.0 (2C), 126.9 (3C), 21.1.
GC: 7e: 9.286 min. GC-MS (m/z): Calcd. 168; Found 168.

29. 4-Chlorotoluene (7f)
Analytically pure product was isolated by a column chromatography on silica gel (hexanes/EtOAc = 50:1). Colorless liquid, Yield: 19.6 mg, 78%. \(^1\)H NMR (600 MHz, CDCl\(_3\), 298 K): \(\delta = 7.21\) (dd, \(3J_{HH} = 8.3\) Hz, 2H, Ph), 7.09 (dd, \(3J_{HH} = 8.1\) Hz, 2H, Ph), 2.32 (s, 3H, CH\(_3\)). \(^{13}\)C\(^{1}\)H NMR (151 MHz, CDCl\(_3\), 298 K): \(\delta = 136.2, 131.0, 130.3\) (2C), 128.2 (2C), 20.8.
GC: 7f: 5.449 min. GC-MS (m/z): Calcd. 126; Found 126.
30. 4-Bromotoluene (7g)
Analytically pure product was isolated by a column chromatography on silica gel (hexanes/EtOAc = 50:1). Light yellow liquid, Yield: 30.1 mg, 88%. $^1$H NMR (600 MHz, CDCl$_3$, 298 K): $\delta$ = 7.37 (dd, $^3J_{HH} = 8.3$ Hz, 2H, Ph), 7.03 (dd, $^3J_{HH} = 8.3$ Hz, 2H, Ph), 2.30 (s, 3H, CH$_3$). $^{13}$C($^1$H) NMR (151 MHz, CDCl$_3$, 298 K): $\delta$ = 136.7, 131.2 (2C), 130.8 (2C), 119.0, 21.0.
GC: 7g: 6.257 min. GC-MS (m/z): Calcd. 171; Found 171.

31. 4-Iodotoluene (7h)
Analytically pure product was isolated by a column chromatography on silica gel (hexanes/EtOAc = 50:1). Colorless liquid, Yield: 38.3 mg, 88%. $^1$H NMR (600 MHz, CDCl$_3$, 298 K): $\delta$ = 7.56 (d, $^3J_{HH} = 8.5$ Hz, 2H, Ph), 6.93 (d, $^3J_{HH} = 8.5$ Hz, 2H, Ph), 2.29 (s, 3H, CH$_3$). $^{13}$C($^1$H) NMR (151 MHz, CDCl$_3$, 298 K): $\delta$ = 137.4, 137.2 (2C), 131.2 (2C), 90.2, 21.0.
GC: 7h: 7.192 min. GC-MS (m/z): Calcd. 218; Found 218.

32. m-Xylene (7j)
Analytically pure product was isolated by a column chromatography on silica gel (hexanes/EtOAc = 50:1). Colorless liquid, Yield: 14.4 mg, 68%. $^1$H NMR (600 MHz, CDCl$_3$, 298 K): $\delta$ = 7.17 (t, $^3J_{HH} = 7.6$ Hz, 1H, Ph), 7.01 (t, $^3J_{HH} = 7.6$ Hz, 3H, Ph), 2.34 (s, 3H, CH$_3$). $^{13}$C($^1$H) NMR (151 MHz, CDCl$_3$, 298 K): $\delta$ = 137.8 (2C), 129.9, 128.1, 126.0 (2C), 21.3.
GC: 7j: 4.076 min. GC-MS (m/z): Calcd. 106; Found 106.

33. o-Xylene (7k)
Analytically pure product was isolated by a column chromatography on silica gel (hexanes/EtOAc = 50:1). Colorless liquid, Yield: 10.6 mg, 50%. $^1$H NMR (600 MHz, CDCl$_3$, 298 K): $\delta$ = 7.15 (m, 2H, Ph), 7.11 (m, 2H, Ph), 2.28 (s, 6H, CH$_3$). $^{13}$C($^1$H) NMR (151 MHz,
CDCl₃, 298 K): δ = 136.5 (2C), 129.5 (2C), 125.7 (2C), 19.7 (2C).

GC: 7k: 4.438 min. GC-MS (m/z): Calcd. 106; Found 106.

34. 1,2,3,5-Tetramethylbenzene (7l)
GC: 7l: 6.165 min. GC-MS (m/z): Calcd. 134; Found 134.

35. 2-Bromo-4-Fluorotoluene (7m)
GC: 7m: 6.017 min. GC-MS (m/z): Calcd. 189; Found 189.

36. 2-Methylnaphthalene (7n)
Analytically pure product was isolated by a column chromatography on silica gel (hexanes/EtOAc = 100:1). White solid, Yield: 24.4 mg, 86%. ¹H NMR (600 MHz, CDCl₃, 298 K): δ = 7.79 (dd, ³JHH = 7.7 Hz, 1H, Ph), 7.75 (t, ³JHH = 6.3 Hz, 2H, Ph), 7.61 (s, 1H, Ph), 7.42 (m, 2H, Ph), 7.32 (d, ³JHH = 8.4 Hz, 1H, Ph), 2.52 (s, 3H, CH₃). ¹³C{¹H} NMR (151 MHz, CDCl₃, 298 K): δ = 135.4 (2C), 133.6, 131.7, 128.1, 127.7, 127.6, 127.2, 126.8, 125.8, 124.9, 21.7.

GC: 7n: 8.318 min. GC-MS (m/z): Calcd. 142; Found 142.

37. 9-Methylanthracene (7o)
Analytically pure product was isolated by a column chromatography on silica gel (hexanes/EtOAc = 100:1). Yellow solid, Yield: 26.5 mg, 69%. ¹H NMR (600 MHz, CDCl₃, 298 K): δ = 8.34 (s, 1H, Ph), 8.29 (d, ³JHH = 8.5 Hz, 2H, Ph), 8.00 (d, ³JHH = 8.5 Hz, 1H, Ph), 7.52 (m, 2H, Ph), 7.46 (m, 2H, Ph), 3.11 (s, 3H, CH₃). ¹³C{¹H} NMR (151 MHz, CDCl₃, 298 K): δ = 130.4 (2C), 129.0 (2C), 128.0 (4C), 124.2 (2C), 123.7 (2C), 123.6 (2C), 12.9.

GC: 7o: 13.397 min. GC-MS (m/z): Calcd. 192; Found 192.

38. 1-Methylpyrene (7p)
Analytically pure product was isolated by a column chromatography on silica gel (hexanes/EtOAc = 20:1). White solid, Yield: 27.2 mg, 63%. $^1$H NMR (600 MHz, CDCl$_3$, 298 K): $\delta$ = 8.25 (d, $^3J_{HH}$ = 8.9 Hz, 1H, Ph), 8.19 (d, $^3J_{HH}$ = 7.3 Hz, 1H, Ph), 8.15 (d, $^3J_{HH}$ = 8.3 Hz, 1H, Ph), 8.12 (d, $^3J_{HH}$ = 9.2 Hz, 1H, Ph), 8.08 (s, 1H, Ph), 8.03 (q, $^3J_{HH}$ = 8.9 Hz, 2H, Ph), 7.99 (t, $^3J_{HH}$ = 7.3 Hz, 1H, Ph), 7.87 (d, $^3J_{HH}$ = 7.7 Hz, 1H, Ph), 2.99 (s, 3H, CH$_3$). $^{13}$C$[^1]$H NMR (151 MHz, CDCl$_3$, 298 K): $\delta$ = 127.8, 127.5, 127.4 (2C), 127.1, 126.4, 125.8, 125.7, 124.9 (2C), 124.8 (3C), 124.7, 124.6, 123.7, 19.8. $^1$H and $^{13}$C NMR spectral data are in good agreement with the literature data.54

39. Propan-2-yloxy[methyl]benzene (9aa)
GC: 9aa: 8.281 min. GC-MS (m/z): Calcd. 150; Found 150. HRMS (ESI) m/z calcd for C$_{10}$H$_{13}$O$^+$ (M+H)$^+$: 151.1014; found: 151.1006.

40. 1-Methyl-4-[(1-Methylethoxy)methyl]benzene (9da)
GC: 9da: 9.493 min. GC-MS (m/z): Calcd. 164; Found 164. HRMS (ESI) m/z calcd for C$_{11}$H$_{17}$O$^+$ (M+H)$^+$: 165.1236; found: 165.1241.

41. 4-[(1-Methylethoxy)methyl]-1,1'-Biphenyl (9ea)
GC: 9ea: 18.226 min. GC-MS (m/z): Calcd. 226; Found 226. HRMS (ESI) m/z calcd for C$_{16}$H$_{19}$O$^+$ (M+H)$^+$: 227.1459; found: 227.1450.

42. 1-Fluoro-4-[(1-Methylethoxy)methyl]benzene (9qa)
GC: 9qa: 8.651 min. GC-MS (m/z): Calcd. 168; Found 168. HRMS (ESI) m/z calcd for C$_{10}$H$_{14}$FO$^+$ (M+H)$^+$: 169.1028; found: 169.1022.

43. 1-Chloro-4-[(1-Methylethoxy)methyl]benzene (9fa)
Analytically pure product was isolated by a column chromatography on silica gel (hexanes/EtOAc = 100:1). Yellow liquid, Yield: 29.4 mg, 80%. $^1$H NMR (600 MHz, CDCl$_3$, 298 K): $\delta$ = 7.30 (m, 4H, Ph), 4.47 (s, 2H, CH$_2$), 3.67 (m, 1H, CH), 1.21 (d, 6H, CH$_3$). $^{13}$C$[^1]$H NMR (151 MHz, CDCl$_3$, 298 K): $\delta$ = 137.6, 133.0, 128.8 (2C), 128.4 (2C), 71.1, 69.2, 22.1 (2C).
GC: 9fa: 10.884 min. GC-MS (m/z): Calcd. 184; Found 184. HRMS (ESI) m/z calcd for
C_{10}H_{18}ClO^+ (M+H)^+: 185.0761; found: 185.0755.

44. 1-Bromo-4-[(1-Methylethoxy)methyl]benzene (9ga)
GC: 9ga: 11.724 min. GC-MS (m/z): Calcd. 229; Found 229. HRMS (ESI) m/z calcd for C_{10}H_{18}BrO^+ (M+H)^+: 229.0274; found: 229.0268.

45. 1-Trifluoromethyl-4-[(1-Methylethoxy)methyl]benzene (9ra)
GC: 9ra: 12.046 min. GC-MS (m/z): Calcd. 218; Found 218. HRMS (ESI) m/z calcd for C_{12}H_{16}F_{3}O^+ (M+H)^+: 219.1066; found: 219.1070.

46. 4-[(1-Methylethoxy)methyl]benzonitrile (9ia)
GC: 9ia: 13.267 min. GC-MS (m/z): Calcd. 175; Found 175. HRMS (ESI) m/z calcd for C_{12}H_{14}NO^+ (M+H)^+: 175.1023; found: 176.1015.

47. 2-[(1-Methylethoxy)methyl]napthalene (9na)
Analytically pure product was isolated by a column chromatography on silica gel (hexanes/EtOAc = 100:1). Yellow liquid, Yield: 32.0 mg, 99%. $^1$H NMR (600 MHz, CDCl$_3$, 298 K): $\delta$ = 7.49 (m, 4H, Ph), 7.34 (t, $^3$J$_{HH}$ = 8.1 Hz, 3H, Ph), 7.25 (t, $^3$J$_{HH}$ = 7.9 Hz, 1H, Ph), 4.47 (s, 2H, CH$_2$), 3.63 (m, 1H, CH), 1.16 (d, 6H, CH$_3$). $^{13}$C($^1$H) NMR (151 MHz, CDCl$_3$, 298 K): $\delta$ = 140.0, 139.3, 137.1, 127.7 (2C), 126.9 (2C), 126.1 (2C), 126.0, 69.9, 68.7, 21.1 (2C).
GC: 9na: 14.664 min. GC-MS (m/z): Calcd. 200; Found 200. HRMS (ESI) m/z calcd for C$_{14}$H$_{12}$O$^+$ (M+H)$^+$: 201.1268; found: 201.1263.

48. 1-Chloro-2-[(1-Methylethoxy)methyl]benzene (9sa)
GC: 9sa: 12.273 min. GC-MS (m/z): Calcd. 184; Found 184. HRMS (ESI) m/z calcd for C$_{10}$H$_{14}$ClO$^+$ (M+H)$^+$: 185.0778; found: 185.0766.

49. 1-Chloro-3-[(1-Methylethoxy)methyl]benzene (9ta)
Analytically pure product was isolated by a column chromatography on silica gel (hexanes/EtOAc = 100:1). Colorless liquid, Yield: 2.4 mg, 10%. \(^1\)H NMR (600 MHz, CDCl\(_3\), 298 K): \(\delta = 7.35\) (m, 4H, Ph), 7.30 (m, 1H, Ph), 4.47 (s, 2H, CH\(_2\)), 3.40 (s, 3H, CH\(_3\)). \(^{13}\)C\(^{1}\)H NMR (151 MHz, CDCl\(_3\), 298 K): \(\delta = 138.2, 128.4\) (2C), 127.7 (2C), 127.6, 74.7, 58.1.
C₈H₁₂O⁺ (M+H)⁺: 123.0865; found: 123.0858.

56. (Ethoxymethyl)benzene (9ac)
Analytically pure product was isolated by a column chromatography on silica gel (hexanes/EtOAc = 100:1). Colorless liquid, Yield: 21.7 mg, 80%. ¹H NMR (600 MHz, CDCl₃, 298 K): δ = 7.35 (m, 4H, Ph), 7.29 (m, 1H, Ph), 4.52 (s, 2H, CH₂), 3.55 (q, 3J_HH = 7.0 Hz, 2H, CH₂), 1.26 (t, 3J_HH = 7.0 Hz, 3H, CH₃). ¹³C{¹H} NMR (151 MHz, CDCl₃, 298 K): δ = 138.6, 128.3 (2C), 127.7 (2C), 127.5, 72.7, 65.7, 15.2.
GC: 9ac: 12.410 min. GC-MS (m/z): Calcd. 136; Found 136. HRMS (ESI) m/z calcd for C₈H₁₂O⁺ (M+H)⁺: 137.0976; found: 137.0964.

57. (Butoxymethyl)benzene (9ad)
Analytically pure product was isolated by a column chromatography on silica gel (hexanes/EtOAc = 100:1). Colorless liquid, Yield: 24.9 mg, 76%. ¹H NMR (600 MHz, CDCl₃, 298 K): δ = 7.34 (d, 3J_HH = 4.8 Hz, 4H, Ph), 7.28 (m, 1H, Ph), 4.51 (s, 2H, CH₂), 3.48 (t, 3J_HH = 6.5 Hz, 2H, CH₂), 1.60 (m, 2H, CH₂), 1.41 (m, 2H, CH₂), 0.92 (t, 3J_HH = 7.4 Hz, 3H, CH₃). ¹³C{¹H} NMR (151 MHz, CDCl₃, 298 K): δ = 138.7, 128.3 (2C), 127.6 (2C), 127.4, 72.8, 70.2, 31.8, 19.4, 13.9.
GC: 9ad: 12.410 min. GC-MS (m/z): Calcd. 164; Found 164. HRMS (ESI) m/z calcd for C₁₁H₁₆O⁺ (M+H)⁺: 165.1294; found: 165.1282.

58. Dibenzyl ether (9ae)
Analytically pure product was isolated by a column chromatography on silica gel (hexanes/EtOAc = 100:1). Colorless liquid, Yield: 29.3 mg, 74%. ¹H NMR (600 MHz, CDCl₃, 298 K): δ = 7.39 (m, 8H, Ph), 7.32 (m, 2H, Ph), 4.59 (s, 4H, CH₂). ¹³C{¹H} NMR (151 MHz, CDCl₃, 298 K): δ = 138.3 (2C), 128.4 (4C), 127.8 (4C), 127.6 (2C), 72.1 (2C).
GC: 9ae: 11.740 min. GC-MS (m/z): Calcd. 198; Found 198. HRMS (ESI) m/z calcd for C₁₄H₁₅O⁺ (M+H)⁺: 199.1125; found: 199.1116.
15. NMR spectra

$^1$H NMR (600 MHz, 298K, CDCl$_3$) of 2a

$^{13}$C NMR (151 MHz, 298 K, CDCl$_3$) of 2a
$^1$H NMR (600 MHz, 298K, CDCl$_3$) of 2b

$^{13}$C NMR (151 MHz, 298 K, CDCl$_3$) of 2b
$^1$H NMR (600 MHz, 298K, CDCl$_3$) of 2c

$^{13}$C NMR (151 MHz, 298 K, CDCl$_3$) of 2c
S41

$\text{H NMR (600 MHz, 298K, CDCl}_3\text{) of 2d}$

$\text{^13C NMR (151 MHz, 298 K, CDCl}_3\text{) of 2d}$
$^1$H NMR (600 MHz, 298K, CDCl$_3$) of 2f

$^{13}$C NMR (151 MHz, 298 K, CDCl$_3$) of 2f
$^1$H NMR (600 MHz, 298K, CDCl$_3$) of 2g

$^{13}$C NMR (151 MHz, 298 K, CDCl$_3$) of 2g
$^1$H NMR (600 MHz, 298K, CDCl$_3$) of 2h

$^{13}$C NMR (151 MHz, 298 K, CDCl$_3$) of 2h
$^1$H NMR (600 MHz, 298K, CDCl$_3$) of 2j

$^{13}$C NMR (151 MHz, 298 K, CDCl$_3$) of 2j
$^1$H NMR (600 MHz, 298K, CDCl$_3$) of 2k

$^{13}$C NMR (151 MHz, 298 K, CDCl$_3$) of 2k
\(^1\)H NMR (600 MHz, 298K, CDCl\(_3\)) of 2n

\(^{13}\)C NMR (151 MHz, 298 K, CDCl\(_3\)) of 2n
$^1$H NMR (600 MHz, 298K, CDCl$_3$) of 2o

$^{13}$C NMR (151 MHz, 298 K, CDCl$_3$) of 2o
S49

$^1$H NMR (600 MHz, 298K, CDCl$_3$) of 2p

$^{13}$C NMR (151 MHz, 298 K, CDCl$_3$) of 2p
$^{1}H$ NMR (600 MHz, 298K, CDCl$_3$) of 2u

$^{13}C$ NMR (151 MHz, 298 K, CDCl$_3$) of 2u
$^1$H NMR (600 MHz, 298K, CDCl$_3$) of 2v

$^{13}$C NMR (151 MHz, 298 K, CDCl$_3$) of 2v
$^1$H NMR (600 MHz, 298K, CDCl$_3$) of 2w

$^{13}$C NMR (151 MHz, 298 K, CDCl$_3$) of 2w
$^1$H NMR (600 MHz, 298K, CDCl$_3$) of 7a

$^{13}$C NMR (151 MHz, 298 K, CDCl$_3$) of 7a
$^1$H NMR (600 MHz, 298 K, CDCl$_3$) of 7b

$^{13}$C NMR (151 MHz, 298 K, CDCl$_3$) of 7b
$^1$H NMR (600 MHz, 298K, CDCl$_3$) of 7d

$^{13}$C NMR (151 MHz, 298 K, CDCl$_3$) of 7d
$^1$H NMR (600 MHz, 298K, CDCl$_3$) of 7e

$^{13}$C NMR (151 MHz, 298 K, CDCl$_3$) of 7e
$^1$H NMR (600 MHz, 298K, CDCl$_3$) of 7f

$^{13}$C NMR (151 MHz, 298 K, CDCl$_3$) of 7f
$\text{H NMR (600 MHz, 298K, CDCl}_3\text{)}$ of $7g$

$\text{C NMR (151 MHz, 298 K, CDCl}_3\text{)}$ of $7g$

$\text{H NMR (600 MHz, 298K, CDCl}_3\text{)}$ of $7g$

$\text{C NMR (151 MHz, 298 K, CDCl}_3\text{)}$ of $7g$
$^1$H NMR (600 MHz, 298K, CDCl$_3$) of 7h

$^{13}$C NMR (151 MHz, 298 K, CDCl$_3$) of 7h
$^1$H NMR (600 MHz, 298K, CDCl$_3$) of 7j

$^{13}$C NMR (151 MHz, 298 K, CDCl$_3$) of 7j
$^1$H NMR (600 MHz, 298K, CDCl$_3$) of 7k

$^{13}$C NMR (151 MHz, 298 K, CDCl$_3$) of 7k
$^1$H NMR (600 MHz, 298K, CDCl$_3$) of 7n

$^{13}$C NMR (151 MHz, 298 K, CDCl$_3$) of 7n
$^{1}$H NMR (600 MHz, 298K, CDCl$_3$) of 7o

$^{13}$C NMR (151 MHz, 298 K, CDCl$_3$) of 7o
$^1$H NMR (600 MHz, 298K, CDCl$_3$) of 7p

$^{13}$C NMR (151 MHz, 298 K, CDCl$_3$) of 7p
$^1$H NMR (600 MHz, 298 K, CDCl$_3$) of 9fa

$^{13}$C NMR (151 MHz, 298 K, CDCl$_3$) of 9fa
$^1$H NMR (600 MHz, 298K, CDCl$_3$) of 9na

$^{13}$C NMR (151 MHz, 298 K, CDCl$_3$) of 9na
$^{1}$H NMR (600 MHz, 298K, CDCl$_3$) of 9ab

$^{13}$C NMR (151 MHz, 298K, CDCl$_3$) of 9ab
$^1$H NMR (600 MHz, 298K, CDCl$_3$) of 9ac

$^{13}$C NMR (151 MHz, 298 K, CDCl$_3$) of 9ac
$^1$H NMR (600 MHz, 298 K, CDCl$_3$) of 9ad

$^{13}$C NMR (151 MHz, 298 K, CDCl$_3$) of 9ad
$^1\text{H} \text{ NMR (600 MHz, 298K, CDCl}_3\text{) of 9ae}$

$^{13}\text{C} \text{ NMR (151 MHz, 298 K, CDCl}_3\text{) of 9ae}$
16. References


