Supplementary Information

The direct synthesis of hydrogen peroxide using a combination of a hydrophobic solvent and water.

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Table S.1. Table S.1. Nominal and actual total metal loading of supported AuPd catalysts as determined by ICP-MS.

Catalyst	Actual Au loading / %	Actual Pd loading / %
2.5%Au-2.5%Pd/TiO_2	2.10	2.15
2.5%Au-2.5%Pd/SiO_2	2.46	2.37
2.5%Au-2.5%Pd/CeO_2	2.34	2.50
2.5%Au-2.5%Pd/C (G60)	2.22	2.50

All catalysts calcined (3 h, 400 °C, 20 °Cmin^{-1}, static air).

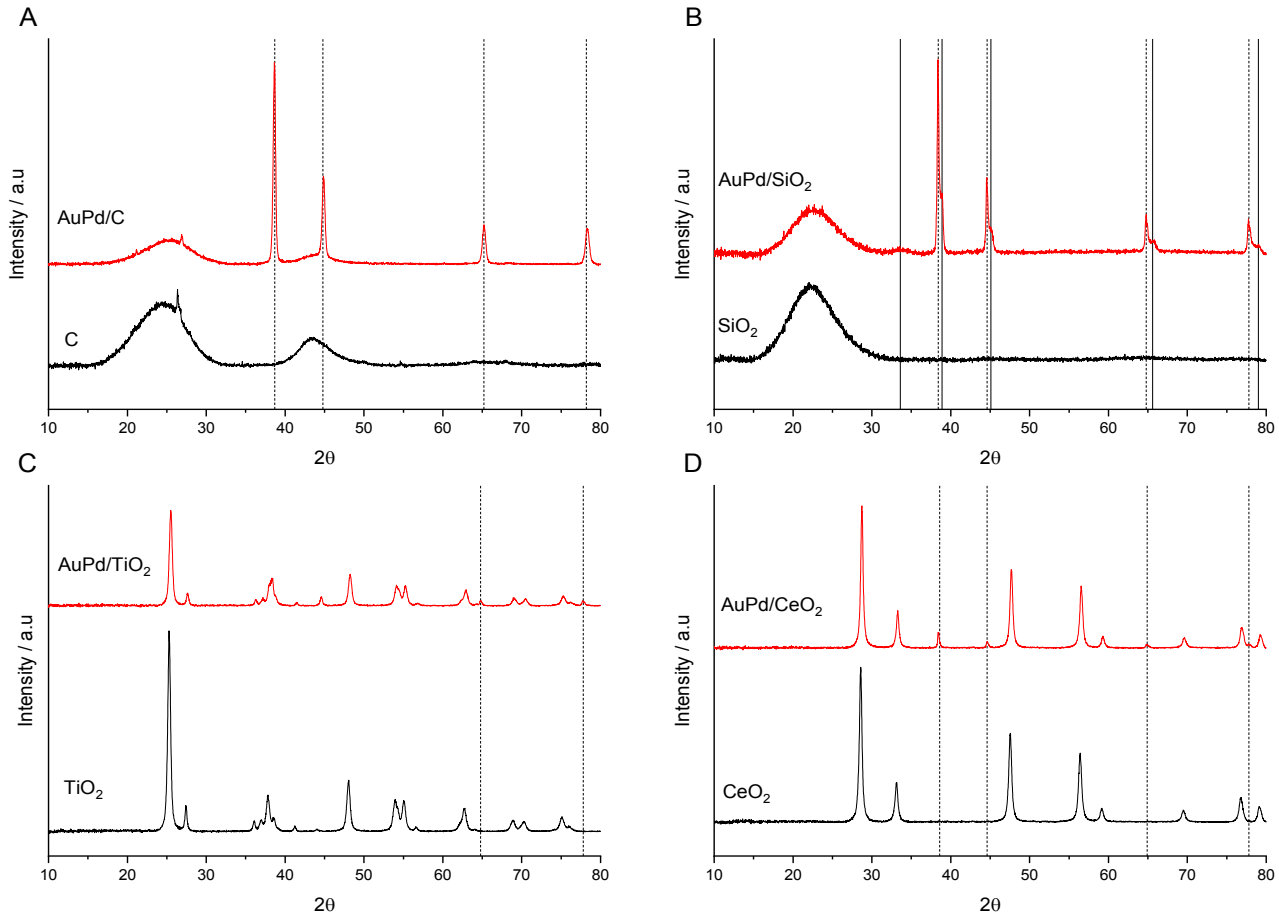

Figure S.1. X-ray diffractograms of AuPd catalysts supported on A)C(G60), B), SiO2 C) TiO2 and D) CeO2 prepared by wet co-impregnation (3 h, 400 °C, static air, ramp rate = 20 °C min^{-1}). Au reflections (dashed lines) Pd reflections (solid lines).

Table S.2. Summary surface atomic concentrations of Au and Pd present in supported AuPd catalysts, as derived from XPS using Au (4f) and Pd (3d) features.

Catalyst	Pd: Au*
2.5%Au-2.5%Pd/TiO_2	46.7
2.5%Au-2.5%Pd/SiO_2	12.2
2.5%Au-2.5%Pd/CeO_2	24.9
2.5%Au-2.5%Pd/C (G60)	0.9

All catalysts calcined (3 h, 400 °C, 20 °Cmin^{-1}, static air).

* Expected value for homogeneous alloy based on Au: Pd = 1: 1 by weight = 1.9.

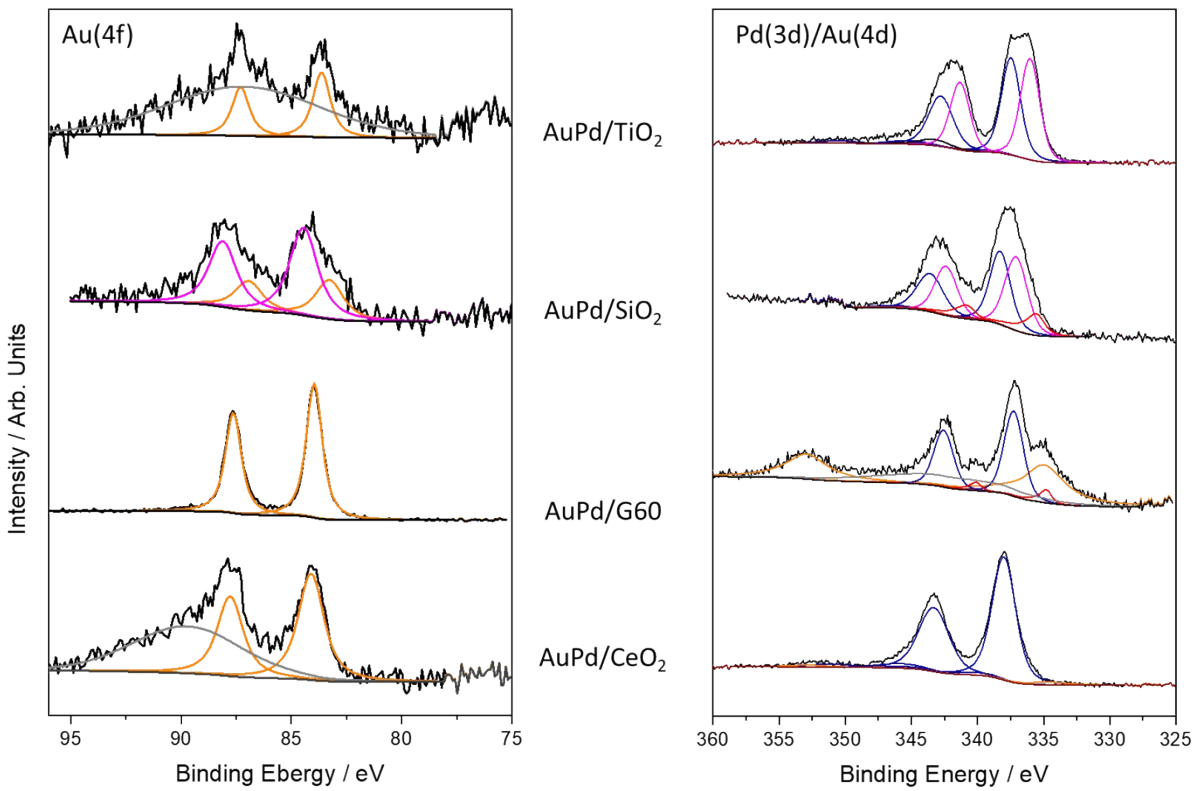

Figure S.2. XPS spectra of Au (4f) and Pd (3d) regions of as prepared A) 2.5%Au-2.5%Pd/ B) 2.5%Au-2.5%Pd/ C) 2.5%Au-2.5%Pd/ and D) 2.5%Au-2.5%Pd/ catalysts.

Table S.3. Catalytic activity towards H_2O_2 synthesis and degradation using a water/methanol solvent system at sub-ambient temperature.

Catalyst	Productivity / $mol_{H2O2}kg_{cat}^{-1}h^{-1}$ [a]	Degradation / % [b]	Reference
2.5%Au-2.5%Pd/TiO_2	64	12	1,2
2.5%Au-2.5%Pd/SiO_2	74	23	3,4
2.5%Au-2.5%Pd/ CeO_2	68	9	5,6
2.5%Au-2.5%Pd/C (G60)	110	5	7, 8

[a] H_2O_2 direct synthesis reaction conditions: Catalyst (0.01 g), H_2O (2.9 g), MeOH (5.6 g), 5% H_2/CO_2 (420 psi), 25% O_2/CO_2 (160 psi), 0.5 h, 2° C, 1200 rpm.
[b] H_2O_2 degradation reaction conditions: Catalyst (0.01 g), H_2O_2 (50 wt.% 0.68 g) H_2O (2.22 g), MeOH (5.6 g), 5% H_2/CO_2 (420 psi), 0.5 h, 2°C, 1200 rpm.
Note: For extensive comparison of catalytic performance as well as the ability of the catalytic support to alter nanoparticle composition and morphology we direct the reader to references 2 and 8.

Table S.4. Catalytic activity towards H_2O_2 synthesis and degradation using a water/decan-1-ol solvent system at ambient temperature.

Catalyst	Productivity / $mol_{H2O2}kg_{cat}^{-1}h^{-1}$ [a]	Degradation / % [b]
2.5%Au-2.5%Pd/TiO_2	24	94
2.5%Au-2.5%Pd/SiO_2	19	99
2.5%Au-2.5%Pd/ CeO_2	13	89
2.5%Au-2.5%Pd/C (G60)	8	37

[a] H_2O_2 direct synthesis reaction conditions: Catalyst (0.01 g), H_2O (2.9 g), MeOH (5.6 g), 5% H_2/CO_2 (420 psi), 25% O_2/CO_2 (160 psi), 0.5 h, 2° C, 1200 rpm.
[b] H_2O_2 degradation reaction conditions: Catalyst (0.01 g), H_2O_2 (50 wt.% 0.68 g) H_2O (2.22 g), MeOH (5.6 g), 5% H_2/CO_2 (420 psi), 0.5 h, 2°C, 1200 rpm.

Table S.5. Observed pressure drop after the addition of reagent gases to different alcohol solvents.

Solvent (8.5 g)	Observed pressure drop /psi*
Methanol	60
Hexan-1-ol	78
Octan-1-ol	87
Decan-1-ol	100

* Initial pressure 580 psi - 5% H_2/CO_2 (420 psi), 25% O_2/CO_2 (160 psi).

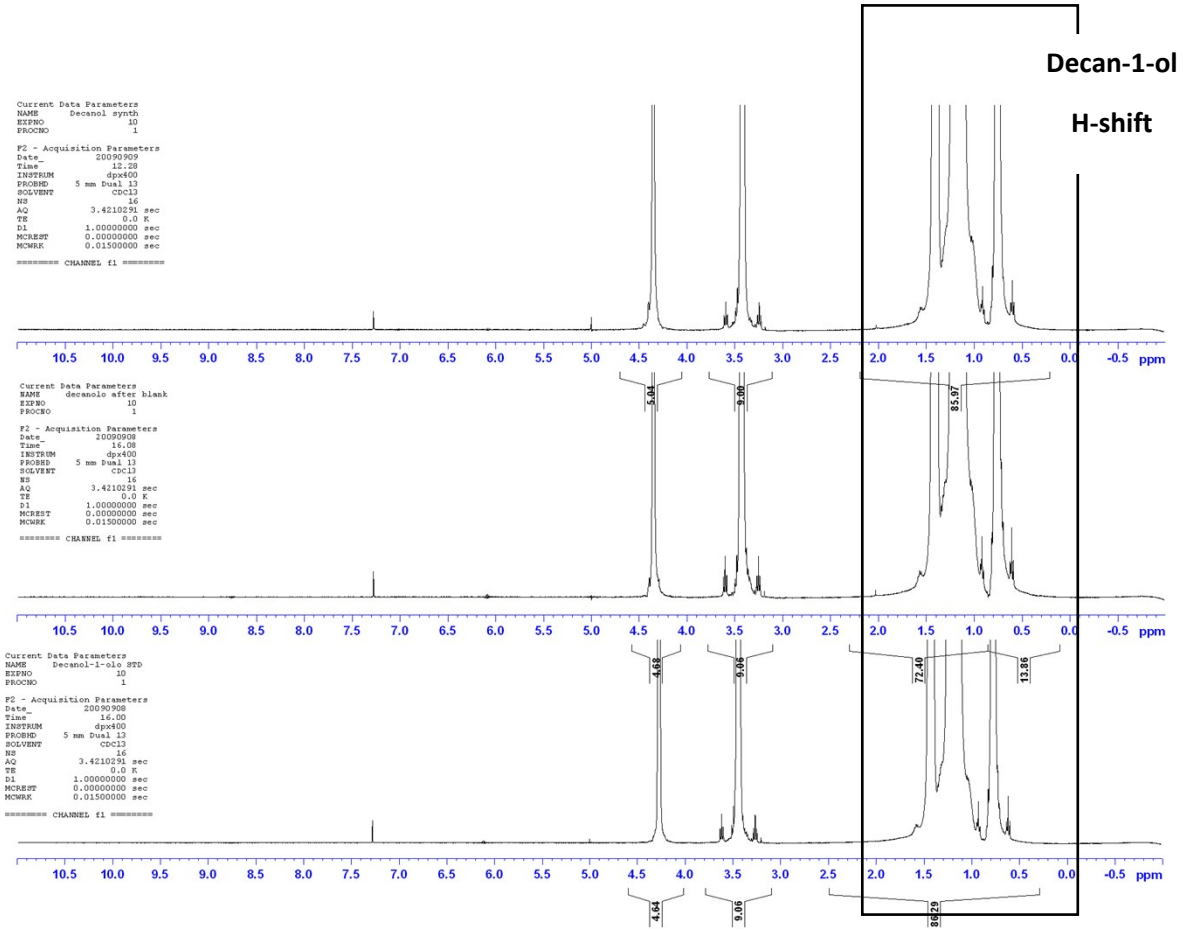

Figure S.3. NMR spectra showing the stability of the decan-1-ol during H_2O_2 synthesis (A) and a blank reaction (B) against a reference Decan-1-ol spectra (C)

References.

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