

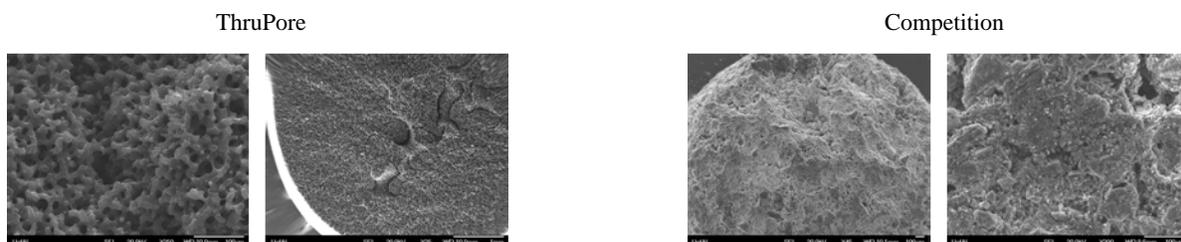


ThruPore Technologies, Inc.

ThruPore Technologies provides off the shelf catalysts and custom catalysts. Our standard catalyst focuses on hydrogenations, common in many petrochemical, chemical intermediate, and pharmaceutical processes. The predominant catalyst used for hydrogenations is Palladium-on-Carbon (Pd/C), and ThruPore offers a family of catalysts listed below.

ThruPore's custom designed catalysts all used its proprietary synthetic carbon supports impregnated with a variety of noble metals, including Ruthenium, Rhodium, and Platinum. ThruPore's uniquely porous, purely synthetic carbon support enables proficient metal dispersion due its highly accessible surface area. Catalytic test data is provided on nine separate reactions using ThruPore's standard Pd/C catalyst compared to standard commercial catalysts. Testing was conducted at ThruPore's laboratory in Tuscaloosa, AL and in certain customer laboratories.

Comparison of Porosity



Comparison of Dispersion



ThruPore's catalyst support has macropores which enhances palladium dispersion.

Value Propositions of ThruPore Catalysts

Customers work with ThruPore to develop new catalysts for different reasons. Here are a few of them:

- Process / production speed is doubled.
- ThruPore's support enabled using 30% to 50% less precious metal to achieve same performance.
- The yield of the end product using ThruPore's catalyst increased by 20%.
- The new process can now be performed under milder conditions (room temp. and atmospheric pressure).
- Desired end product (or by-product) was so pure, an entire process step was eliminated.
- ThruPore's inherent porosity improved the safety of the process to become feasible. (Safety issues were caused by carbon clogging and/or removing pressure drops).

Catalysts should be measured by a Productivity Improvement Ratio. Below is an example comparison test:

Catalyst	% Conversion	% Selectivity	Lifetime	Productivity
Compet.	100	40	6-8 months	414
ThruPore	100	60	> 2 years	1861
Productivity = kg product/L catalyst/during useful life Productivity Ratio = 4.5				

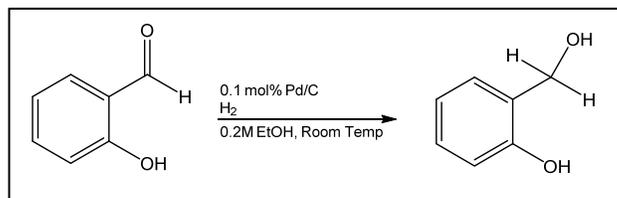
Standard Palladium-on-Carbon Catalysts – PoroCat X and PoroSelect

PoroCat X is a pelletized catalyst that is ideally suited for fixed bed reactors and is provided with a 1 wt% Pd loading. The tests below have all been performed with PoroCat X. The higher activity of PoroCat X allows for less catalyst loading and more mild conditions can be used when compared to a leading palladium on carbon extrudate.

PoroSelect is a powdered catalyst ideally suited where higher selectivity is desired. PoroSelect is provided in 1 wt% and 5 wt% Pd. Reactions are best run using more mild conditions (room temperature & atmospheric pressure) for optimum selectivity.

Hydrogenation of Salicylaldehyde

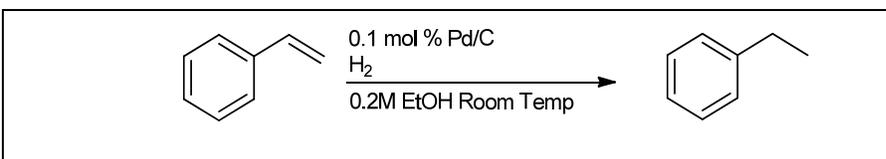
PoroCat X catalyst shows high activity in producing the end product salicylalcohol. ThruPore achieves 95% conversion where the competitive catalyst achieves 10% in the same reaction time.



Catalyst	Time (hours)	Percent Conversion
ThruPore PoroCat X 1%	24	95%
Competition 1%	24	10%

Hydrogenation of Styrene

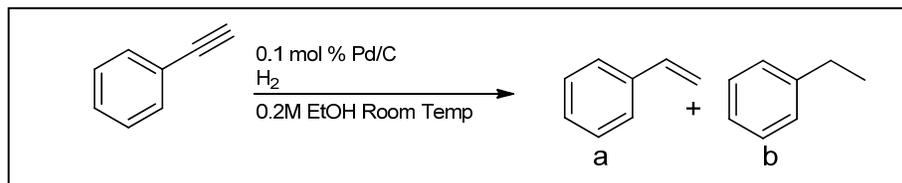
PoroCat X catalyst exhibits 4x higher activity in producing the end product in 1 hour with 100% conversion.



Catalyst	Time (hours)	Percent Conversion
ThruPore	1	100%
Competition	4	100%

Hydrogenation of Phenylacetylene

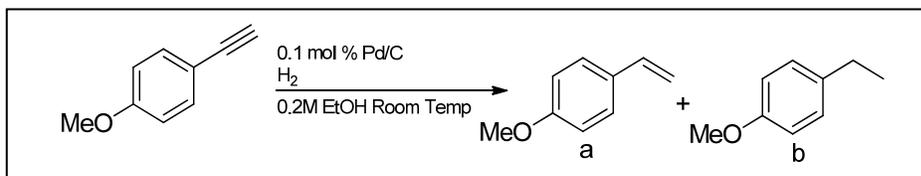
PoroCat X catalyst shows 4x higher activity in producing the end product with 100% conversion. The end Product (b) is ethyl benzene, and Product (a) is styrene.



Catalyst	Time (hours)	Percent Conversion
ThruPore	4	100% (37% a, 63% b)
ThruPore	6	100% b
Competition	6	100% (46% a, 54% b)
Competition	24	100% b

Hydrogenation of 4-Ethynylanisole

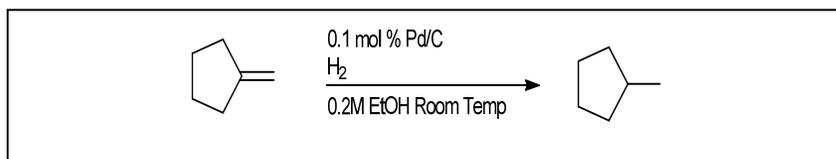
PoroCat X catalyst shows high activity - 6 times faster than competitor to achieve 100% conversion to Product (b), ethyl anisole. In 2 hours, the reaction showed 43% conversion to Product (a), methoxy styrene. Note that the competitive catalyst was incapable of producing the end desired Product (b), leaving 16% of original feedstock, where PoroCat X achieved the fully hydrogenated Product (b).



Catalyst	Time (hours)	Percent Conversion
ThruPore	2	100% (43% a, 57% b)
ThruPore	4	100% b
Competition	24	84% (80% a, 4% b)

Hydrogenation of Methylene-cyclopentane

Hydrogenating methylene-cyclopentane is a hard reaction because there are no electron donating or withdrawing groups associated. This test shows that ThruPore converts ~25% more than competitor.



Catalyst	Time (hours)	Percent Conversion
ThruPore	24	78%
Competition	24	56%

Hydrogenation of Ethyl Linoleate



* The ethyl linoleate employed is composed of 79 % 18:2, 18 % 18:1, and 3% 18:0, based on GC.

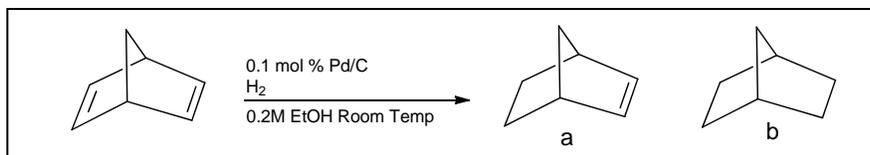
Catalyst	Reaction Conditions			Conversion (%)	Selectivity (%)	
	H ₂ (psi)	Temp (°C)	Time (hrs)		18:1 (%)	18:0 (%)
ThruPore	14.7	60	3	99	92	7
Competition	14.7	60	3	14	3	11

PoroSelect catalyst at 1% loading showed high selectivity with 92% of the product being the partially hydrogenated ethyl oleate. The competition showed a total of 14% conversion with only 3% of the product being desired ethyl oleate.

Hydrogenation of Norbornadiene

PoroSelect catalyst at 1% loading showed high selectivity with 100% conversion of the reaction to Product (a) norbornene in 2 hours.

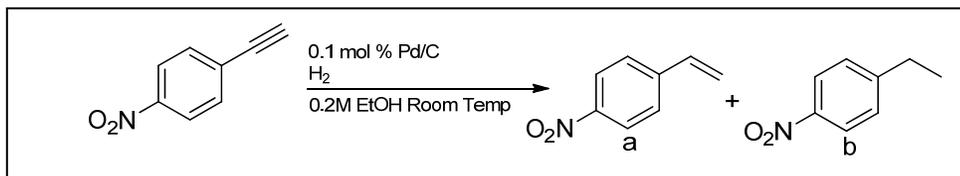
Product (b), norbornane, was also fully isolated. Note that the competitive catalyst never achieves full conversion of Product (b).



Catalyst	Time (hours)	Percent Conversion
ThruPore	2	100% (100% a, 0% b)
ThruPore	24	100% (0% a, 100% b)
Competition	2	87% a
Competition	24	100% (21% a, 79% b)

Hydrogenation of 1-Ethynyl-4-Nitrobenzene

PoroSelect catalyst at 1% wt loading shows high activity, 6 times faster than competitor to achieve 100% conversion to Product (b), 1-ethyl-4-nitrobenzene.



In 2 hours, the reaction showed 86% conversion to Product (a), 4-nitrosyrene, also showing high selectivity. Note that the

competitive catalyst was incapable of producing the end desired Product (b), leaving 5% of original feedstock, where PoroSelect achieved fully hydrogenated Products.

Catalyst	Time (hours)	Percent Conversion
ThruPore	2	100% (86% a, 14% b)
ThruPore	4	100% b
Competition	24	95% (10% a, 85% b)

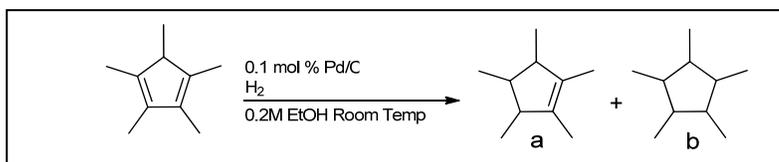
Hydrogenation of Pentamethylcyclopentadiene

PoroSelect catalyst at 1% loading showed high selectivity. After 7 hours, competitor has 12% of starting material remaining, while ThruPore has fully hydrogenated all starting material.

Product (a) is pentamethylcyclopentene and

Product (b) is penta-methylcyclopentane.

ThruPore produced 62% of b after 7 hours, twice as much as competitor in same time window.



Catalyst	Time (hours)	Percent Conversion
ThruPore	7	100% (38% a, 62% b)
ThruPore	24	100% (25% a, 75% b)
Competition	7	88% (53% a, 35% b)
Competition	24	100% (41% a, 59% b)