



## **HeraSelect® — Precious Metal Catalysts on Activated Carbon**

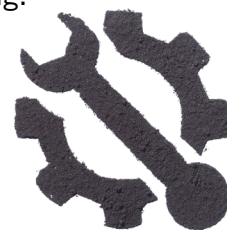
The Catalyst That Fits Your Process — Not Just Your Spec Sheet

## THE RIGHT CATALYST STARTS WITH YOUR PROCESS

Carbon-supported precious metal catalysts with the same nominal specification can perform very differently. Choosing the right catalyst therefore requires more than selecting a precious metal and its loading.

Catalyst A (5%Pd/C)  $\neq$  Catalyst B (5%Pd/C)

The carbon support, precious metal precursor and catalyst synthesis all influence the properties of the final catalyst. Differences in porosity, surface chemistry, metal dispersion and metal-support interactions can translate into significantly different catalytic performance – even at identical nominal precious metal loading.



## KEY FACTORS INFLUENCING CATALYST PERFORMANCE

### CARBON SUPPORT

- › Porosity & surface area
- › Surface chemistry
- › Particle size distribution
- › Purity
- › Filterability

### PRECIOUS METAL / PRECURSOR

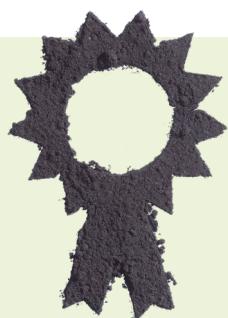
- › Pt · Pd · Rh · Ru
- › Metal loading
- › Precursor type
- › Reduction behaviour

### CATALYST SYNTHESIS

- › Distribution of active sites
- › Metal-support interaction
- › Crystallite size

### SHAPE & GEOMETRY

- › Powder
- › Granules
- › Extrudates
- › Other forms



## PERFORMANCE IS MORE THAN ACTIVITY

The most active catalyst in a laboratory test is not automatically the best catalyst for an industrial process. Depending on the application, catalyst selection may need to balance:



#### Activity

Reaction rate and conversion



#### Selectivity

Formation of the desired product



#### Stability

Performance under the relevant reaction environment



#### Processability

Filtration, handling and compatibility with the reactor concept



#### Overall Process Performance

Productivity, reproducibility and efficient operation

## THE RIGHT CATALYST IS THE ONE THAT FITS YOUR PROCESS.

Understanding the reaction chemistry, process conditions and performance requirements is the starting point for selecting the most suitable catalyst.

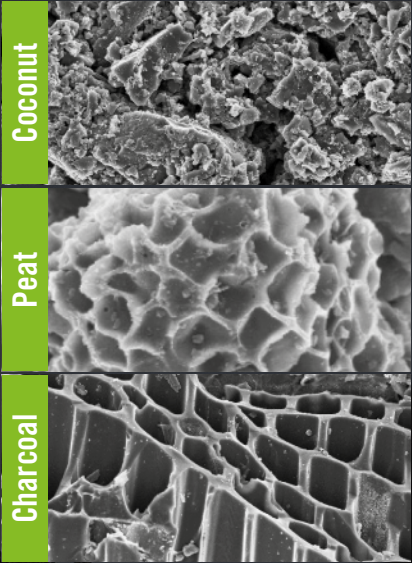


## ACTIVATED CARBON AS CATALYST SUPPORT

Activated carbon combines high surface area, tunable porosity, adsorption capacity and chemical stability. These properties make it an effective support for precious metal catalysts, while also making support selection a critical design decision.

Carbon materials differ in their raw material, activation method, post-treatment, pore structure, surface chemistry, purity and particle size distribution. These differences influence how the precious metal is deposited, how the catalytically active sites are distributed and how the catalyst behaves during reaction and filtration.

## CARRIER CHOICE

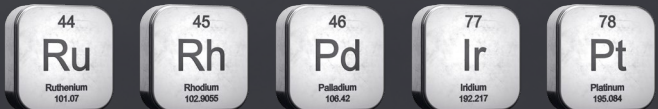


|                 |                                                                                                                                                                                               |                    |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| RAW MATERIAL    | Wood<br>Peat                                                                                                                                                                                  | Nutshell<br>Others |
| CARBON SHAPE    | Powder<br>Granules                                                                                                                                                                            | Strands<br>Spheres |
| CHARACTERISTICS | High specific surface area: BET 700-1500 m <sup>2</sup> /g<br>Bulk density: 250 – 500 g/l<br>Diverse pore structures<br>Huge adsorption capacity<br>Chemically stable under acidic conditions |                    |
| PRE-TREATMENT   | Chemically: Phosphoric acid activated<br>Physically: Steam activated                                                                                                                          |                    |
| POST-TREATMENT  | Acid washed<br>Non-acid washed                                                                                                                                                                |                    |

## CIRCLEAR – PRODUCTS MADE WITH 100% RECYCLED PLATINUM GROUP METALS



Using recycled platinum group metals (PGMs) can support your Scope 3 greenhouse gas reduction strategy: Depending on the metal, the industry average emission factor of secondary PGMs are 98.2% to 98.8% lower than those of primary PGMs.<sup>1</sup> Meanwhile, precious metals that are recovered using recycling processes have the same high quality and purity as primary metals. All Circlear precious metals are 100% recycled, based on mass balance approach<sup>2</sup> verified by TÜV Süd in accordance with ISO 14021. The metals originate from secondary sources such as spent chemical or automotive catalysts.



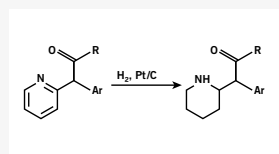
<sup>1</sup> Comparisons are based on data from International Platinum Group Metals Association, “The Life Cycle Assessment of Platinum Group Metals”, 2025 (reference year 2022).

<sup>2</sup> Circlear uses mass-balance allocation. The physical precious metal in an individual delivery is not necessarily traceable exclusively to secondary feedstock. For every quantity sold as Circlear, an equivalent quantity of precious metal from secondary sources has been acquired by Heraeus.

## REPRESENTATIVE CATALYTIC CONVERSIONS FROM OUR APPLICATION LIBRARY

### Hydrogenation of Pyridines to Piperidines

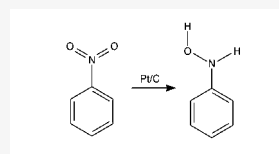
5% Pt/C, reduced



- **Surface Area BET:** 900 – 1000 m<sup>2</sup>/g
- **Particle Size Distribution (D<sub>90</sub>):** 75 – 85 μm
- **Pore Volume:** 1.9 – 2.1 ml/g
- **Form:** Black fine powder, 50 w% water content

### Nitroaromatic compound to aromatic hydroxylamine

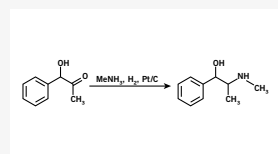
5% Pt/C, reduced



- **Surface Area BET:** 800 – 1000 m<sup>2</sup>/g
- **Particle Size Distribution (D<sub>90</sub>):** 75 – 85 μm
- **Pore Volume:** 1.1 – 1.5 ml/g
- **Form:** Black fine powder, 50 w% water content

### Reductive Amination of Aliphatic Ketones

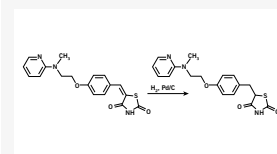
5% Pt/C, reduced



- **Surface Area BET:** 800 – 1000 m<sup>2</sup>/g
- **Particle Size Distribution (D<sub>90</sub>):** 75 – 85 μm
- **Pore Volume:** 1.1 – 1.5 ml/g
- **Form:** Black fine powder, 50 w% water content

### Alkene Hydrogenation

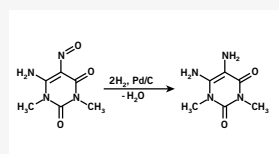
10% Pd/C, reduced



- **Surface Area BET:** 800 – 1000 m<sup>2</sup>/g
- **Particle Size Distribution (D<sub>90</sub>):** 100 – 115 μm
- **Pore Volume:** 1.1 – 1.5 ml/g
- **Form:** Black fine powder, 50 w% water content

### Nitroso Hydrogenation

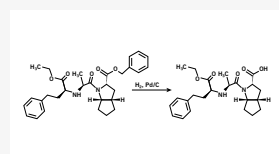
5% Pd/C, unreduced



- **Surface Area BET:** 1000 – 1100 m<sup>2</sup>/g
- **Particle Size Distribution (D<sub>90</sub>):** 75 – 85 μm
- **Pore Volume:** 2.0 – 2.2 ml/g
- **Form:** Black fine powder, 50 w% water content

### Debenzylation

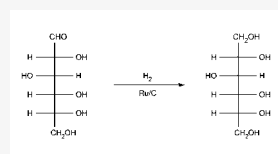
5% Pd/C, unreduced



- **Surface Area BET:** 800 – 1000 m<sup>2</sup>/g
- **Particle Size Distribution (D<sub>90</sub>):** 100 – 115 μm
- **Pore Volume:** 1.1 – 1.5 ml/g
- **Form:** Black fine powder, 50 w% water content

### Hydrogenation of an Aliphatic Aldehyde

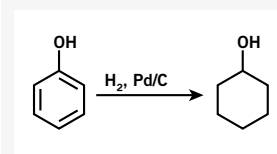
5% Ru/C, unreduced



- **Surface Area BET:** 800 – 1000 m<sup>2</sup>/g
- **Particle Size Distribution (D<sub>90</sub>):** 75 – 85 μm
- **Pore Volume:** 1.1 – 1.5 ml/g
- **Form:** Black fine powder, 50 w% water content

### Ring Hydrogenation

5% Ru/C, unreduced



- **Surface Area BET:** 800 – 1000 m<sup>2</sup>/g
- **Particle Size Distribution (D<sub>90</sub>):** 75 – 85 μm
- **Pore Volume:** 1.9 – 2.1 ml/g
- **Form:** Black fine powder, 50 w% water content

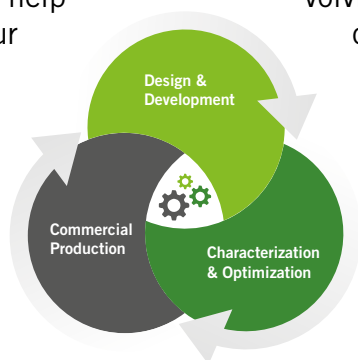
## CUSTOMIZED SOLUTIONS

Many chemical and physical parameters can affect a catalyst's performance. To help you identify the right catalyst for your process, Heraeus provides expert guidance. Often, impressive results can be achieved with a proprietary catalyst. However, customer-specific solutions that go beyond standard products often require individualized catalyst optimization.

Under confidential disclosure agreements (NDAs), Heraeus collaborates close-

ly with you to develop tailor-made solutions, involving thorough testing and extensive characterization of the produced catalyst materials. The wide variety of available materials and production methods allows catalyst properties to be tailored to the relevant reaction parameters.

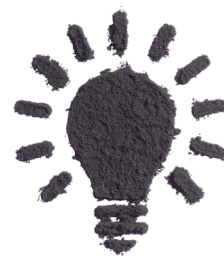
Identifying the catalyst that best matches your reaction and process requirements is where Heraeus expertise makes the difference.



## PROPRIETARY PGM/C CATALYSTS AS A STARTING POINT

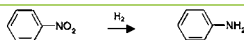
Different reactions and process conditions require different catalyst properties. HeraSelect® provides a broad portfolio of carbon-support-

ed precious metal catalysts as a starting point for identifying the right fit for your application.



### NITRO AND NITROSO COMPOUNDS

Aromatic nitro compounds to anilines



Pt/C

✓

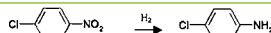
Pd/C

✓

Ru/C

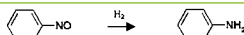
Rh/C

Halonitroaromatics to halogenated anilines



✓

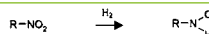
Nitroso compounds to anilines



✓

✓

Nitro compounds to hydroxylamines



✓

### CARBONYL COMPOUNDS

Ketones/aldehydes to alkanes



✓

✓

Ketones/aldehydes to alcohols



✓

✓

✓

### AROMATICS

Ring hydrogenation



✓

✓

✓

✓

Aromatic ketones to alicyclic alcohols



✓

✓

✓

✓

Anilines to cyclohexanones



✓

✓

Dehydrogenation



✓

### C-C MULTIPLE BONDS

Alkenes to alkanes



✓

✓

Alkynes to alkenes/alkanes



✓

✓

$\alpha,\beta$ -unsaturated carbonyl compounds

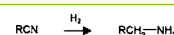


✓

✓

### NITRILES

Nitriles to prim./sec./tert. amines

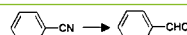


✓

✓

✓

Aromatic nitriles to aldehydes

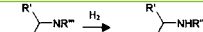


✓

✓

### IMINES AND OXIMES

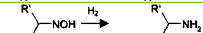
Imines to amines



✓

✓

Oximes to amines

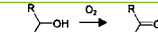


✓

✓

### OXIDATION AND DEHALOGENATION

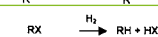
Alcohols to aldehydes and ketones



✓

✓

Dehalogenation X = Cl, Br, I



✓

Additionally, Heraeus offers the customization and fine-tuning of a catalyst to identify a catalyst tailored to your application requirements.



## SAMPLE KIT – TEST BEFORE YOU COMMIT

Heraeus has developed an extensive portfolio of proprietary catalysts, designed for a variety of challenging catalytic reactions. To help identify the right catalyst for your specific process, Heraeus offers catalyst sample kits.

There may already be a catalyst that suits your process, or it could serve as the foundation for an improved, tailor-made catalyst adapted to your requirements.

Contact us  
to request your  
sample kit.



## ABOUT HERAEUS PRECIOUS METALS

Heraeus Precious Metals is one of the world's leading players in the precious metals industry. As part of the Heraeus Group, the company covers the value chain from trading to precious metals products to refining and recycling. It has extensive expertise in all platinum group metals as well as gold and silver.

With about 2,500 employees at 11 sites worldwide, Heraeus Precious Metals offers a broad portfolio of products that are essential for many industries such as the automotive, chemicals, semiconductor, aerospace, pharmaceutical and hydrogen industry.



Our production sites in Hanau, Germany, and Visakhapatnam, India, contribute complementary manufacturing capabilities to our international network. **By making catalysts manufactured in India available to customers in Europe, we broaden our portfolio and strengthen supply security.**



## CONTACT

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**Request your sample kit at**  
[chemicals@heraeus.com](mailto:chemicals@heraeus.com)