

*CATALYSTS TO SPEED UP
YOUR BUSINESS*



HeraSelect®

**Precious Metal Catalysts
on Activated Carbon**

PRECIOUS METAL CATALYSTS ON ACTIVATED CARBON



More than 80 percent of all reactions in the chemical industry are carried out with the help of catalysts. The synthesis of active pharmaceutical ingredients as well as specialty and fine chemicals is often done in the liquid phase.

Through a unique and diverse portfolio, Heraeus is able to offer precious metal catalysts together with attractive services from a single source.

Precious metal catalysts on activated carbon have often proved successful for this type of reactions.

A RELIABLE PARTNER

As an independent PM/C catalyst supplier, Heraeus is not a competitor but a true partner. Heraeus collaborates closely with its customers to optimize or develop the ideal catalyst for their applications. As a reliable partner, Heraeus stands for long-term relationships and increases its customers' process efficiency through its experience and technical expertise in the field of supported catalysts.



CATALYST SPECIALIST

Heraeus has many years of expertise in the field of catalysts for process chemistry and offers a comprehensive range of in-house produced precious metal precursors and heterogeneous catalysts. This enables Heraeus to support its customers with technical solutions along the entire value chain.



AROUND THE GLOBE ... AND AROUND THE CLOCK

Business is a 24 / 7 enterprise. Companies cannot afford to sleep. That is why Heraeus has established a global network to provide you with continuous access and a complete range of services for all your needs. Our

global coverage is designed to always be there ... whenever you need us.

With our global production sites in Germany, the US and China, we are able to produce close to our customers wherever they are and within customs borders, while maintaining the same high quality all over the world.

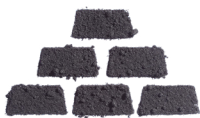
All of our major production facilities comply with governmental, federal, state and municipal laws and regulations and are ISO 9001 and 14001 certified to Quality and Environmental Management Standards.



MATERIALS AND PERFORMANCE

ACTIVATED CARBON AS CATALYST SUPPORT

Its outstanding chemical and physical properties make activated carbon an ideal catalyst support. Carbon materials differ by origin (e.g. wood, peat, or coconut shell), as well as by pre-treatment method (e.g. steam activated, chemically activated, or, for improved purity, acid-washed). The resulting surface chemical characteristics play an important role in the quality of the final catalyst.



PRECIOUS METALS

In addition to the catalyst support, another important contributor to catalyst quality is the precious metal compound that is used. The most frequently used precious metal is palladium, followed by platinum. Other elements such as ruthenium and rhodium

are chosen for special applications. The catalytically active precious metal is present on the material in finely divided form.

PERFORMANCE

An optimized catalyst must exhibit high activity to be able to convert the starting material into the desired product with the highest yield and the shortest reaction time. Another decisive factor is selectivity, which prevents the formation of undesired side products. Along with this, the mechanical strength and filterability, to enable rapid and low-loss separation of the catalyst from the product, are also important.

With products that meet the highest quality standards, Heraeus ensures continuous production processes at its customers and thus strengthens their competitiveness.

CUSTOMIZED SOLUTIONS

Many chemical and physical parameters can affect a catalyst. For this reason, we offer our customers expert advice to identify the ideal catalyst for a specific process. Impressive results can often be achieved with a standard catalyst product. Customer-specific solutions that go beyond a standard product require individualized catalyst optimization. Heraeus works closely with its customers to develop tailor-made solutions. This involves testing and extensive characterization of the produced catalyst materials.

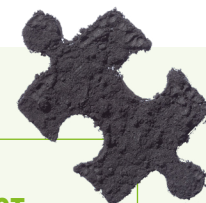
The wide variety of possible materials and production methods allows optimum adaptation to the given reaction parameters. Targeted selection of the best catalyst with the highest activity – that's what we do!

SAMPLE KIT – FINDING THE RIGHT CATALYST

Heraeus has already built up a large portfolio of proprietary catalysts, tailored for various challenging catalytic reactions. To identify the best catalyst for your specific process, Heraeus offers catalyst sample kits.

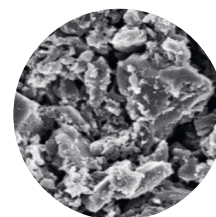
There may already be a catalyst for your process. It can also form the basis for an improved tailor-made catalyst that is adapted to your requirements.

Contact us for our sample kits.

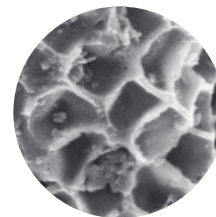


ACTIVATED CARBON AS CATALYST SUPPORT

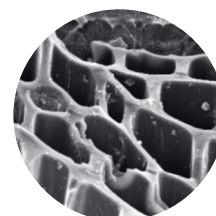
RAW MATERIAL	<ul style="list-style-type: none"> › Wood › Peat 	<ul style="list-style-type: none"> › Nutshell › Others 	
CARBON SHAPE	<ul style="list-style-type: none"> › Powder › Granules 	<ul style="list-style-type: none"> › Strands › (Micro-)Spheres 	<ul style="list-style-type: none"> › Pellets › Others
CHARACTERISTICS	<ul style="list-style-type: none"> › High specific surface area (BET): 800 – 1500 m²/g › Bulk density: 250 – 500 g/L › Diverse pore structures › Huge adsorption capacity › Chemically stable under acidic conditions › Good filterability 		
PRE-TREATMENT	<ul style="list-style-type: none"> › Chemical: Phosphoric acid activated › Physical: Steam activated 		
POST-TREATMENT	<ul style="list-style-type: none"> › Acid washed › Non-acid washed 		



Coconut



Peat



Charcoal

CARBON SHAPES



Powder



Microspheres



Strands



Trilobes



Granules



Pellets

POLYMER-BASED ACTIVATED CARBON MICROSPHERES

Polymer-based spherical activated carbon catalysts combine the advantages of a powder (very high BET surface area of approx. 1000 m²/g) with the positive properties of a stable bulk material (a high crushing strength). Carbon microsphere-based catalysts can be employed both in batch and continuous reactor operations.

- › Up to 5 % precious metal loading (Pt or Pd)
- › PM surface area: 0.4 – 2.5 m²/g up to 3 m²/g
- › Different sizes between 200 – 600 µm
- › Bulk density: approx. 600 g/L
- › pV between 0.08 – 0.18
- › High crushing strength
- › BET surface area of approx. 1000 m²/g
- › Catalyst pH between 5 – 6





APPLICATIONS OF PM/C CATALYSTS

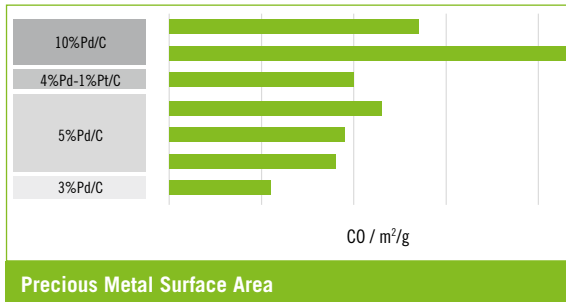
Each chemical reaction has its own chemical and physical constraints. The experts of Heraeus will help you in identifying, optimizing and developing catalysts that are suited to your particular conditions.

PM/C materials can catalyze a vast range of chemical reactions. The most important reactions, as well as appropriate catalysts, are shown in the following table:

		Pt/C	Pd/C	Ru/C	Rh/C
NITRO AND NITROSO COMPOUNDS					
Aromatic nitro compounds to anilines		✓	✓		
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			✓		
α,β -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			✓		

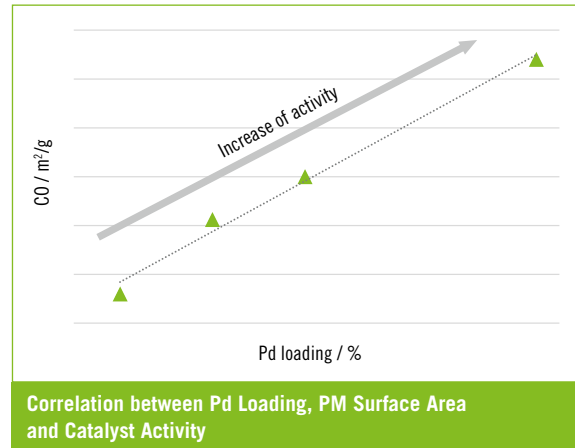
APPLICATION EXAMPLES: PROPERTIES OF PD/C CATALYSTS

PRECIOUS METAL SURFACE AREA OF PD/C CATALYSTS



- Carbon monoxide adsorbs only on the PM and not on the carbon support
- The higher the PM surface area, the smaller are the PM particles on the carbon support

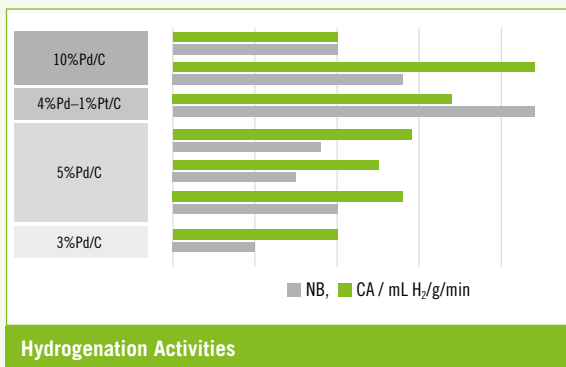
INFLUENCE OF PD LOADING ON CATALYST ACTIVITY



- Linear dependence of catalyst activity on precious metal loading and surface area

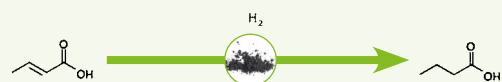
Higher PM loading → Higher activity → Less catalyst needed

HYDROGENATION ACTIVITY OF PD/C CATALYSTS

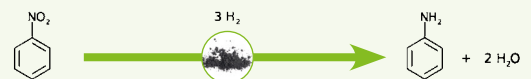


- High activity in the hydrogenation of crotonic acid and nitrobenzene
- Added Pt boosts the hydrogenation of nitrobenzene
- Catalysts' respective hydrogenation activities depend on the substrate and the reaction conditions

■ Crotonic Acid (CA) Hydrogenation



■ Nitrobenzene (NB) Hydrogenation



SERVICES



CONTRACT MANUFACTURING

In addition to producing customized catalysts, we also offer the contract manufacturing of precious metal catalysts on activated carbon supports according to customer formulations under toll contracts.

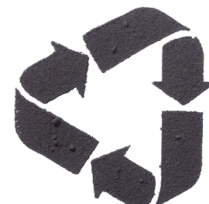
PRECIOUS METALS TRADING

Through our trading centers in Hanau (Germany), New York City, Shanghai and Hong Kong, we are able to execute precious metal trades under current market conditions. In addition to sales and purchasing transactions, we can provide financing options to our customers based on precious metal leasing.



PRECIOUS METALS RECYCLING

As specialists in the handling of spent precious metal catalysts, we offer the fastest possible precious metal recovery with the highest yield. The reclaimed precious metal can be used again for the manufacture of new catalysts.



SCREENING

We are able to conduct comprehensive chemical and physical property determinations in our laboratories using in-house testing equipment. This includes measurements of the precious metal concentration, specific and precious metal surface areas, activity, selectivity, bulk density, particle size and mechanical strength.

ABOUT HERAEUS PRECIOUS METALS

Heraeus Precious Metals is globally leading in the precious metals industry. The company is part of the Heraeus Group and covers the value chain from trading to precious metals products to recycling. It has extensive expertise in all platinum group metals as well as gold and silver.

With about 3,000 employees at 15 sites worldwide, Heraeus Precious Metals offers a broad portfolio of products that are essential for many industries such as the automotive, chemicals, semiconductor, pharmaceutical, hydrogen and jewelry industry.

By 2025 Heraeus Precious Metals will be the first company in the industry that operates carbon neutral.



Heraeus Precious Metals

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