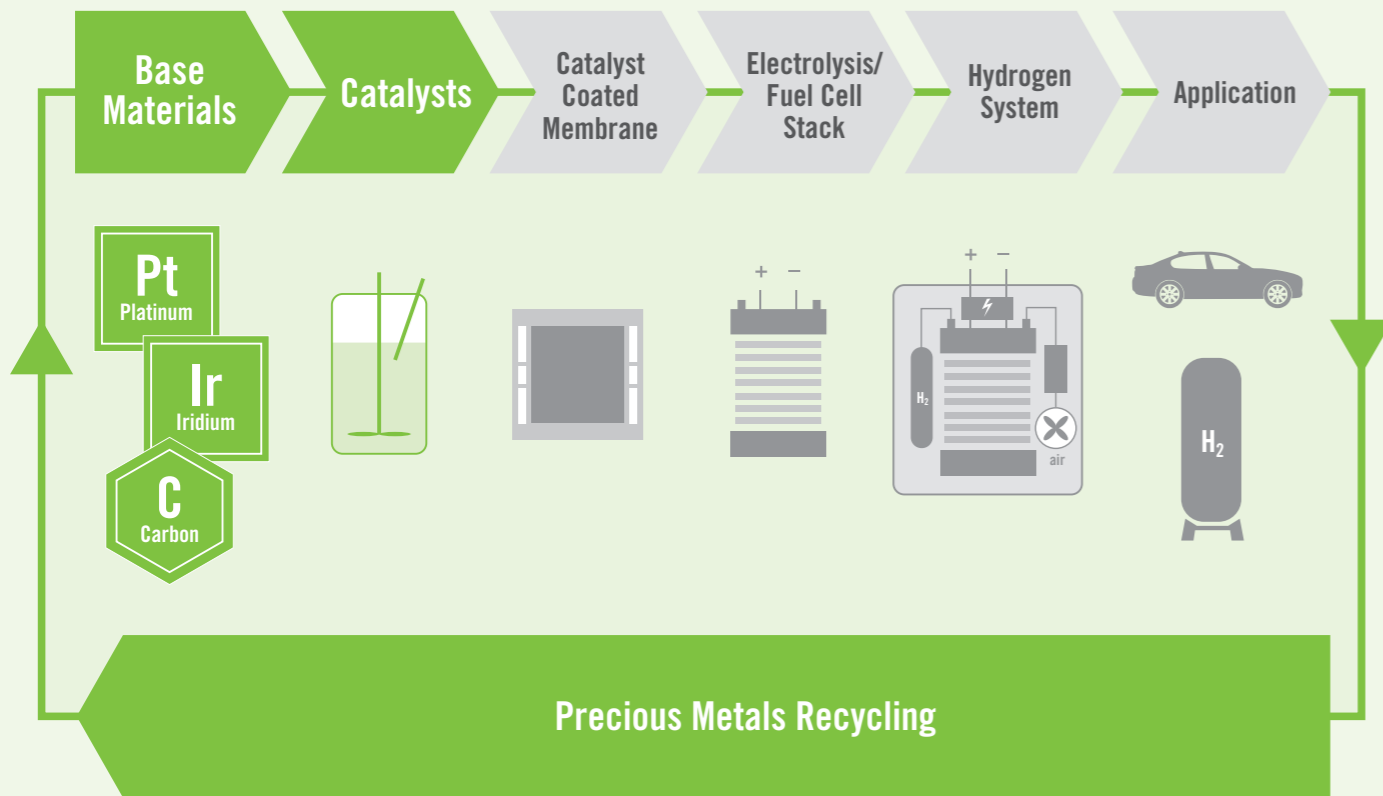


Electrocatalysts for
PEM Fuel Cells

Heraeus Hydrogen Systems



Heraeus – Catalyzing the Hydrogen Revolution

The combustion of fossil resources leads to emissions of CO₂, which is widely recognized as greenhouse gas. The decarbonization of the transport and energy sector are pivotal to limit the negative influence of global warming. **Fuel Cells** are becoming more and more prominent as an **environmentally friendly option in energy generation** for mobility or stationary applications using Green Hydrogen from renewable energy sources.

The cost-efficient production of **Green Hydrogen** on an industrial scale will be **the decisive component** on our way towards a **zero-emission society**. Heraeus is **providing** Fuel Cell catalysts for the use of Green Hydrogen as a source of energy.

PEM Fuel Cell technology will play an important role in the use of Green Hydrogen. Heraeus is aware that the inevitable use of precious metal systems might create challenges for every operating company. That is why your best choice is to work with the **leading provider of precious metals as your partner** to master those challenges.

Heraeus has been **committed to precious metals** since more than 160 years. Utilizing profound expertise in precious metals catalysts, particularly in Platinum on Carbon catalysts, Heraeus is providing **electrocatalysts for PEM Fuel Cells** that offer high stability, activity, and excellent cell reversal tolerance.

Besides the **superior catalyst range, you benefit from** an extensive portfolio of **precious metal services** which increases the planning reliability of your business. Achieve higher margins and focus on your core business by trusting the leading precious metal experts.

Join us in catalyzing the Hydrogen Revolution!

Most suitable catalyst applications



Stationary



MHV



Marine vessels



Passenger vehicles



Heavy duty vehicles

Heraeus focuses on Fuel Cell catalysts for E-mobility and offers three catalysts which are most suitable for passenger vehicles and heavy-duty vehicles applications.

Using Germany as a basis for comparison, it has been predicted that the demand of Hydrogen for passenger as well as heavy duty vehicles will increase drastically in the next 10 – 30 years,

summing up to a collective demand of 200 – 290 TWh by 2050. (Source: Fraunhofer Institut, Eine Wasserstoff Roadmap für Deutschland)

The foreseeable **growth of Hydrogen demand** for these segments reflects the importance of Heraeus as your partner for the **future upscaling of this business.**

Heraeus delivers values for your business

Heraeus Fuel Cell catalysts address tunable activity levels as well as excellent stability. Our Fuel Cell catalysts deliver the following benefits:



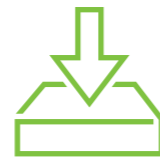
ACTIVITY

Efficient use of Platinum in different catalyst concepts allows to increase performance and reduce costs



STABILITY

With stability comes reliability, our catalysts will contribute to a higher lifetime in your application



CELL REVERSAL TOLERANCE

This feature protects the anode by allowing significantly lower damage throughout time

Our comprehensive product portfolio fits your needs

Catalyst	H2FC-30Pt-C60T	H2FC-30Pt-C60T+ OER additive	H2FC-40Pt-C240	H2FC-50Pt-C700
Features	Pt on Heraeus Carbon material	Application of an Ir-containing OER additive	Highly dispersed Pt on Medium Surface Area Carbon Black	High performance Pt on High Surface Area Carbon Black
Application focus	Highly stable anode – cell reversal tolerance	Highly stable anode – Adjustable cell reversal tolerance	Anode and Cathode – High precious metal efficiency	Cathode – High performance catalyst
Electrochemical Active Surface Area [m ² /g Pt]	> 45 (RDE)	> 45 (RDE)	> 75 (RDE)	> 85 (RDE)
Cell voltage @ 0.1 A/cm ² (CCM)* [V]	~ 0.80	~ 0.80	~ 0.82	~ 0.85
Cell reversal tolerance time until -1.25 V _{cell} (s)	70	> 6500 (15 µg _i /cm ²)	Not applicable	Not applicable

Our product portfolio includes Fuel Cell catalysts with **different precious metal loadings**. These provide numerous benefits to your application. In order to find the perfect solution to your needs, we are able to test in our **fully equipped on site laboratories and test center.**

For more detailed information about our **broad product portfolio and for specific requests** please contact our sales experts.

For questions on our other catalysts from the field of Fuel Cells, please contact our sales experts.

Precious Metal Services

As a leading provider of precious metals, Heraeus offers you **professional management** of your precious metal assets via weight accounts, as well as recycling and refining of precious metals from a wide variety of starting materials, including logistics and waste management.

Heraeus has long-lasting experience and available capacities for recovering precious metals from a catalyst-coated membrane (CCM), which has been a challenge for the market in the past. Trust the expert for CCM **recycling that provides you with a complete loop of your precious metal needs.**

A LOCAL PARTNER ... AND A GLOBAL COMPANY

- Being part of the global Heraeus group, the local teams have access to a worldwide network of experts ensuring fast response to technical and commercial inquiries
- Production facilities and labs in Hanau, Germany and Nanjing, China offer on-site support as well as a large portfolio of related services

MORE THAN JUST RELIABLE PROCUREMENT

Dealing with precious metals can be challenging for you – for Heraeus, it is daily business. As **longstanding experts in precious metals**, Heraeus turns volatile markets into business opportunities. Whatever your need, you can rely on special expertise in **all aspects of physical and non-physical precious metals management.**



Hanau, Germany



Nanjing, China

PRECIOUS METALS TRADING

- Stable physical supply of all precious metals – including the rare PGM Iridium – due to global access to precious metals
- Four global Heraeus Trading offices across all relevant time zones enable seamless coordination across borders for your local requirements
- Financing and Risk Management/Price Hedging services optimize your precious metals procurement and secure your long-term profitability in the light of price volatility on the markets
- Digital One-Stop Solution myHeraeus.com: Comprehensive digital platform – including trading and recycling transactions myHeraeus.com offers full transparency of precious metals pool accounts and transaction history

Heraeus recycles your CCM and recovers your assets with the utmost transparency and maximum yield!

RECYCLING

Long lifetime is one of the key advantages of Hydrogen systems. But it is crucial to think about the future. Recovery of precious metals and the **treatment of spent CCMs** play an important role to implement Hydrogen systems in an economically viable and sustainable way. However, CCM recycling can be a challenge as fluorine-containing material imposes **specialized requirements in process, knowhow and equipment.**

As a leading provider with decades of experience in the recycling of precious metals, Heraeus has the technological competencies to **handle the full recycling process of CCMs.** All kinds of precious metals containing waste are processed, including the **recovery of Iridium** – a very complex process not many companies master. Heraeus experts ensure that your materials are handled in compliance with all applicable regulations. The recycling services are **fast, transparent** and provide you with the **maximum yield.**

Want to gain greater planning security while minimizing your price risks? Heraeus has a unique price hedging model that is right for your profitability!

About Heraeus

Heraeus Precious Metals is a leading provider of precious metals services and products. We combine all activities related to our comprehensive expertise in the precious metals loop – from trading to precious metals products to recycling.

With technical expertise, commitment to excellence, focus on innovation and entrepreneurial leadership, we are constantly striving to improve our performance. We create high-quality solutions for our clients and strengthen their long-term competitiveness by combining unique material expertise with leadership in technology

HERAEUS PRECIOUS METALS

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