

Heraeus

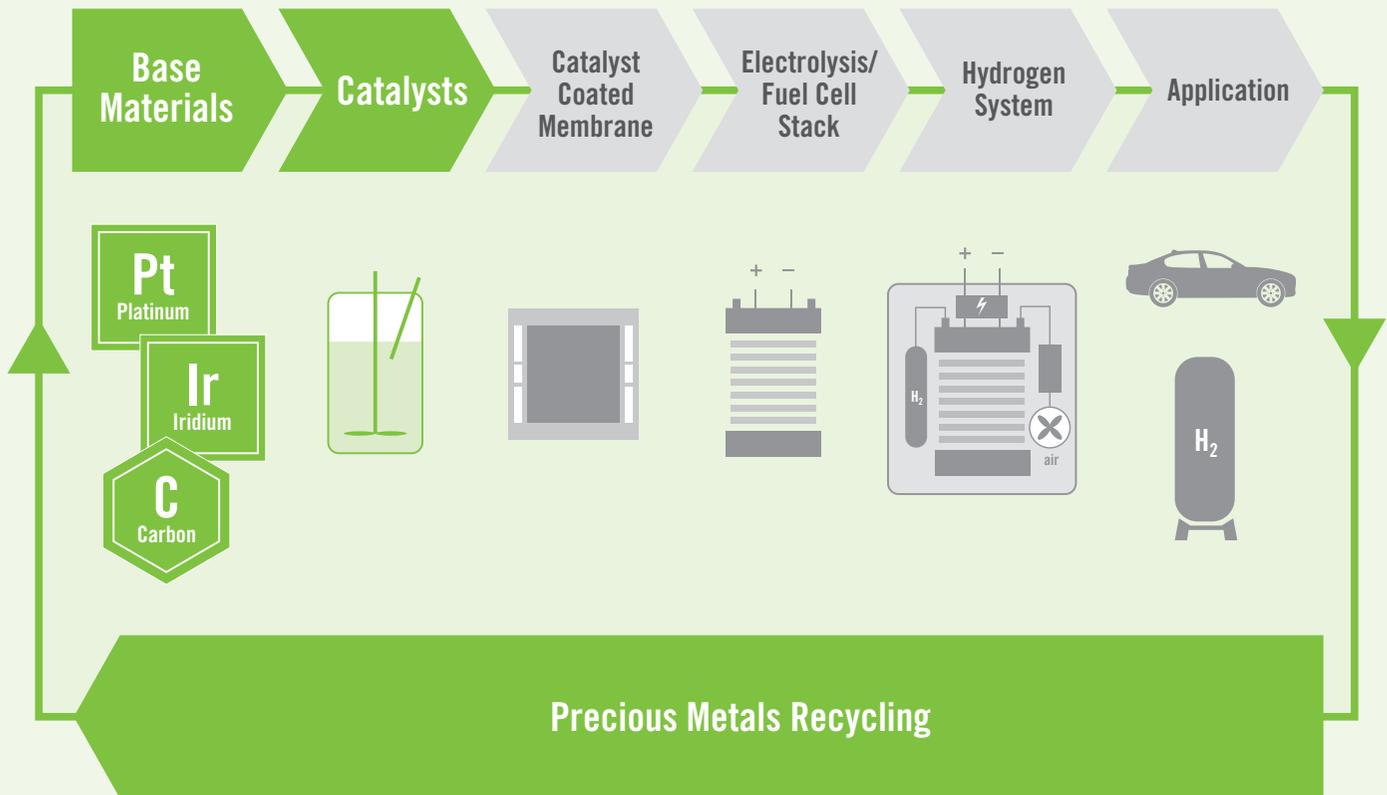
Explore our
new generation
of electrolyzer
anode catalysts and

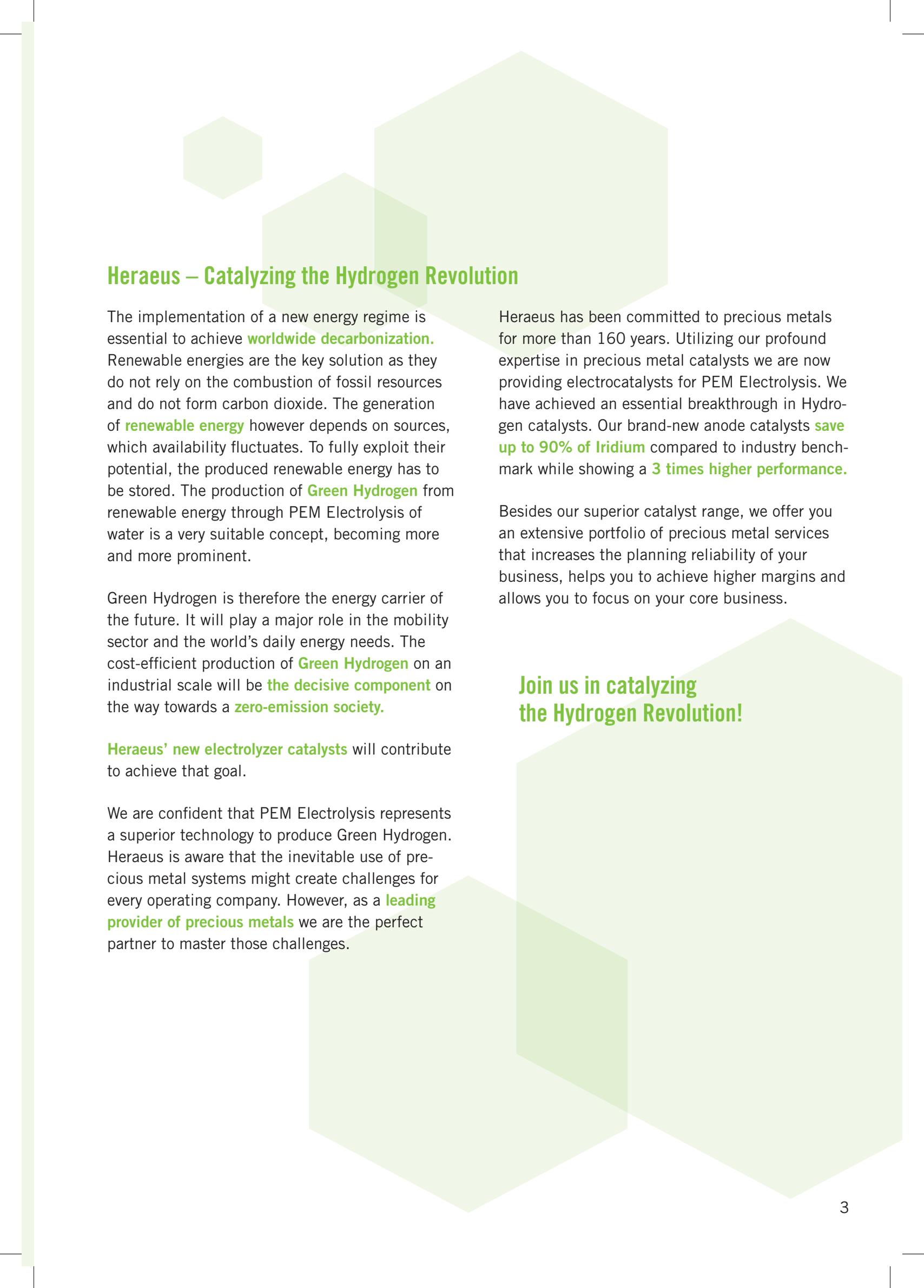
**save up
to 90%
Iridium!**

**Electrocatalysts for
PEM Electrolyzers**



Heraeus Hydrogen Systems





Heraeus – Catalyzing the Hydrogen Revolution

The implementation of a new energy regime is essential to achieve **worldwide decarbonization**. Renewable energies are the key solution as they do not rely on the combustion of fossil resources and do not form carbon dioxide. The generation of **renewable energy** however depends on sources, which availability fluctuates. To fully exploit their potential, the produced renewable energy has to be stored. The production of **Green Hydrogen** from renewable energy through PEM Electrolysis of water is a very suitable concept, becoming more and more prominent.

Green Hydrogen is therefore the energy carrier of the future. It will play a major role in the mobility sector and the world's daily energy needs. The cost-efficient production of **Green Hydrogen** on an industrial scale will be **the decisive component** on the way towards a **zero-emission society**.

Heraeus' new electrolyzer catalysts will contribute to achieve that goal.

We are confident that PEM Electrolysis represents a superior technology to produce Green Hydrogen. Heraeus is aware that the inevitable use of precious metal systems might create challenges for every operating company. However, as a **leading provider of precious metals** we are the perfect partner to master those challenges.

Heraeus has been committed to precious metals for more than 160 years. Utilizing our profound expertise in precious metal catalysts we are now providing electrocatalysts for PEM Electrolysis. We have achieved an essential breakthrough in Hydrogen catalysts. Our brand-new anode catalysts **save up to 90% of Iridium** compared to industry benchmark while showing a **3 times higher performance**.

Besides our superior catalyst range, we offer you an extensive portfolio of precious metal services that increases the planning reliability of your business, helps you to achieve higher margins and allows you to focus on your core business.

**Join us in catalyzing
the Hydrogen Revolution!**

Heraeus delivers value for your business

Heraeus electrolyzer catalysts address decreased Iridium content while increasing efficiency and performance. Our electrolyzer catalysts deliver the following benefits:



ACTIVITY

Efficient use of Iridium in different catalyst concepts allows to increase performance & reduce costs



STABILITY

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



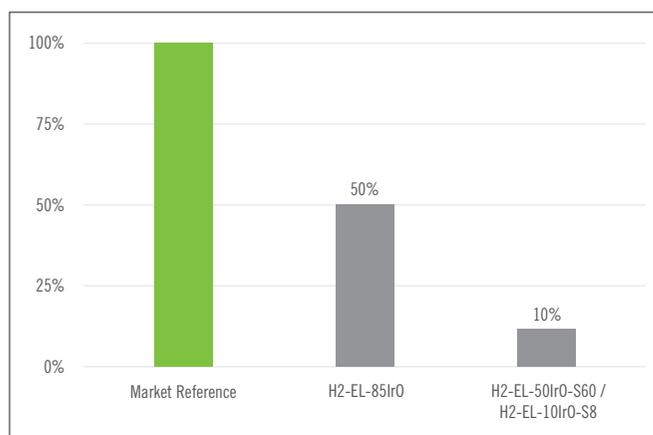
IRIDIUM SAVING

Ideal for large scale application due to significant savings in precious metal content

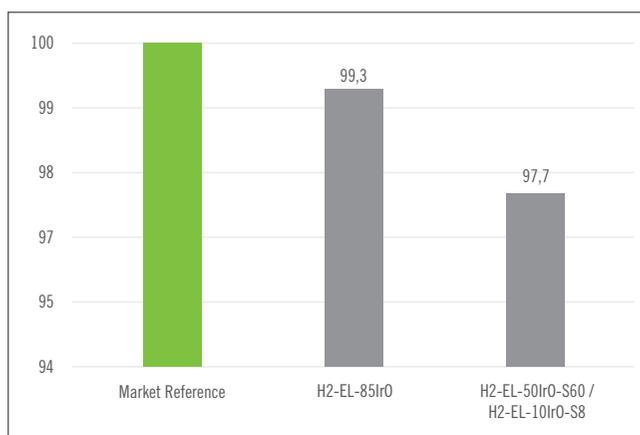


ELECTRODE AREA SAVING

Strong decrease in capital expenditure due to Iridium and catalyst material savings



Iridium content benchmark



Necessary electrode area benchmark

Heraeus catalysts save 50–90% on Iridium compared to the market's benchmark!

Catalyst	Electrode area saving	Iridium saving
Market Reference	Benchmark	Benchmark
H2-EL-85IrO	0.7%	Up to 50%
H2-EL-10IrO-S8	3.3%	Up to 90%

based on single cell measurements at 80°C

We achieved breakthrough innovation by supplying electrolyzer catalysts with significantly reduced precious metal loading. Our product will provide you with an up to three times higher catalyst performance while reducing the precious metal loading by 50–90% in comparison to the competition.

These two proven benefits allow you to **save on precious and rare Iridium** as well as on the other electrolyzer components. This favors the application of Heraeus catalysts on large scale processes and promotes the implementation of Hydrogen systems in our society.

Given their lower loadings of Iridium, Heraeus Catalysts 10–70% IrOx/support (H2-EL-50IrO-S60 / H2-EL-10IrO-S8) prove to have a viable chance to win the race to become **the electrocatalyst of choice for PEM Electrolysis** as in 2030 Europe will target 40 GW of PEM electrolyzer.

Our comprehensive product portfolio fits your needs

Catalyst	H2-EL-Ir	H2-EL-85IrO	H2-EL-50IrO-S60 / H2-EL-10IrO-S8	H2-EL-70IrRu
Features	High metal purity	High surface area material	Reduced Ir content	Reduced Ir content
Performance focus	Highly active, stable	Highly active, highly stable	Excellent activity	Excellent activity
Ir crystallite size [nm]	3 (XRD)	2 – 4	2.5 – 3.5, partly amorphous	2.5 – 3.5; partly amorphous
BET surface area [m ² /g]	~ 60	175 – 195	20 – 70	120 – 200
Current density @ 1.5 (RDE)* [mA /mg]	~100	~135	~ 330 (45%) ~ 522 (30%)	~ 100 – 1000

Our product portfolio includes electrolyzer 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.

Total Ir consumption by electrocatalyst type targeting 40 GW



- EU Commission Green Hydrogen target to install 40 GW of Electrolyzers by 2030
- Based on est. 50% of PEM EL Share by 2030
- Based on est. 30% of PEM EL Share by 2025 with target of 6 GW

Precious Metal Services

As a leading provider of precious metals, we offer **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.

Recovering precious metals from a catalyst coated membrane (CCM) remains a challenge for the market. Heraeus, however takes care of **recycling CCMs, providing you with a complete loop of your precious metal needs.**

A LOCAL PARTNER ... AND A GLOBAL COMPANY

- Being part of the global Heraeus group, our local team has access to a worldwide network of experts ensuring fast response to technical and commercial inquiries
- Our production facilities and labs in Hanau, Germany and Nanjing, China allow us to offer you 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 us it is daily business. As **longstanding experts in precious metals**, we turn volatile markets into business opportunities for our customers. Whatever your need, you can rely on our 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
- Our four global 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

We can recycle your CCM and recover 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, we have the technological competencies to **handle the full recycling process of CCMs.** We handle all kinds of precious metals containing waste, including the **recovery of Iridium** – a very complex process not many companies master. Our experts ensure that your materials are handled in compliance with all applicable regulations. Our recycling services are **fast, transparent** and provide you with the **maximum yield.**

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

Catalyzing the Hydrogen Revolution

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

The data given in this brochure are valid for 2021. Subject to alterations.

HERAEUS PRECIOUS METALS

Heraeus Deutschland GmbH & Co. KG
Heraeusstraße 12–14
63450 Hanau, Germany

+ 49 (0) 6181 35-4232
youn-chong.choi@heraeus.com

www.herae.us/hydrogen-systems