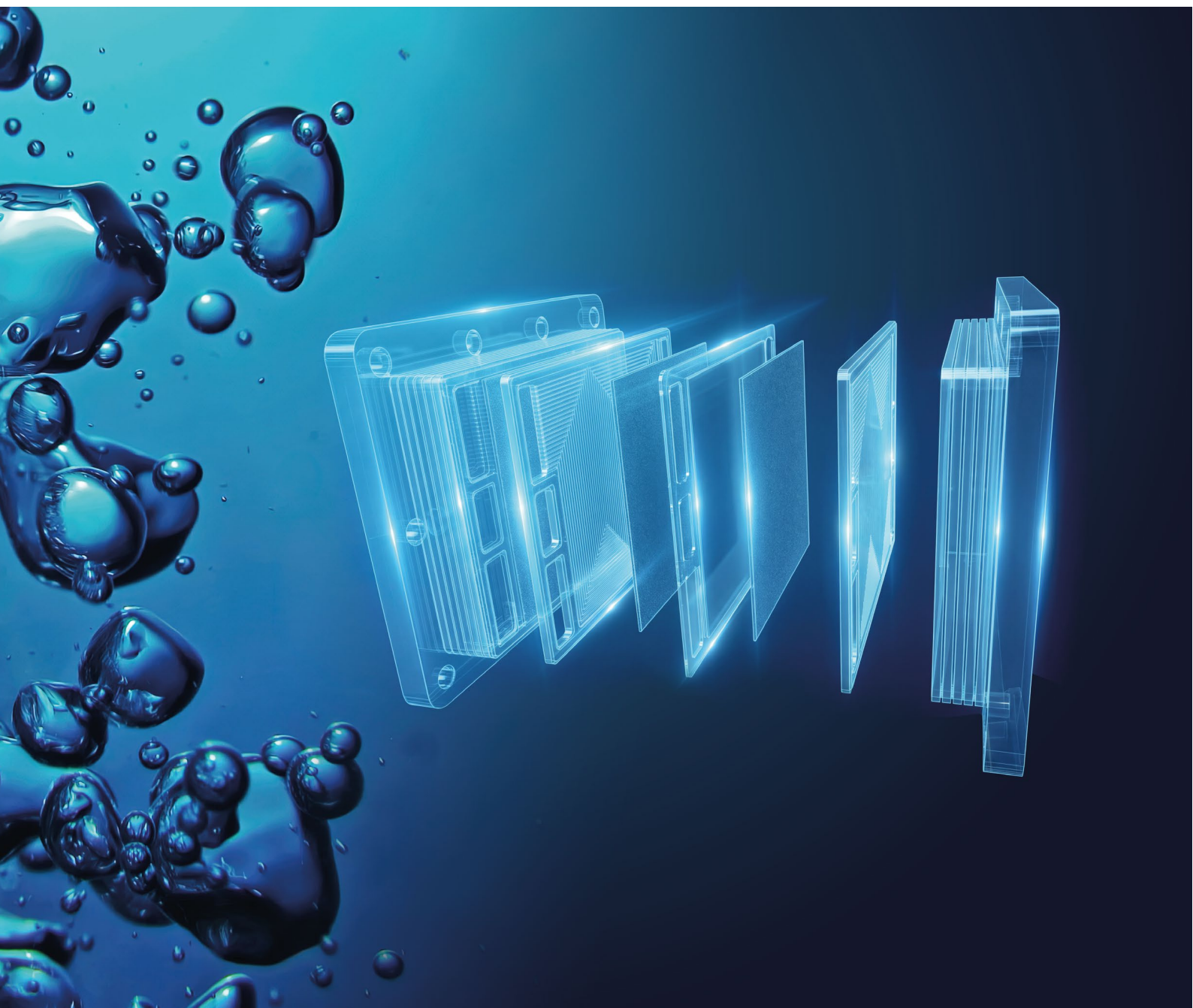




Electrocatalysts for Fuel Cells

Actydon | Platinum

Actydon | Iridium

Fuel Cells

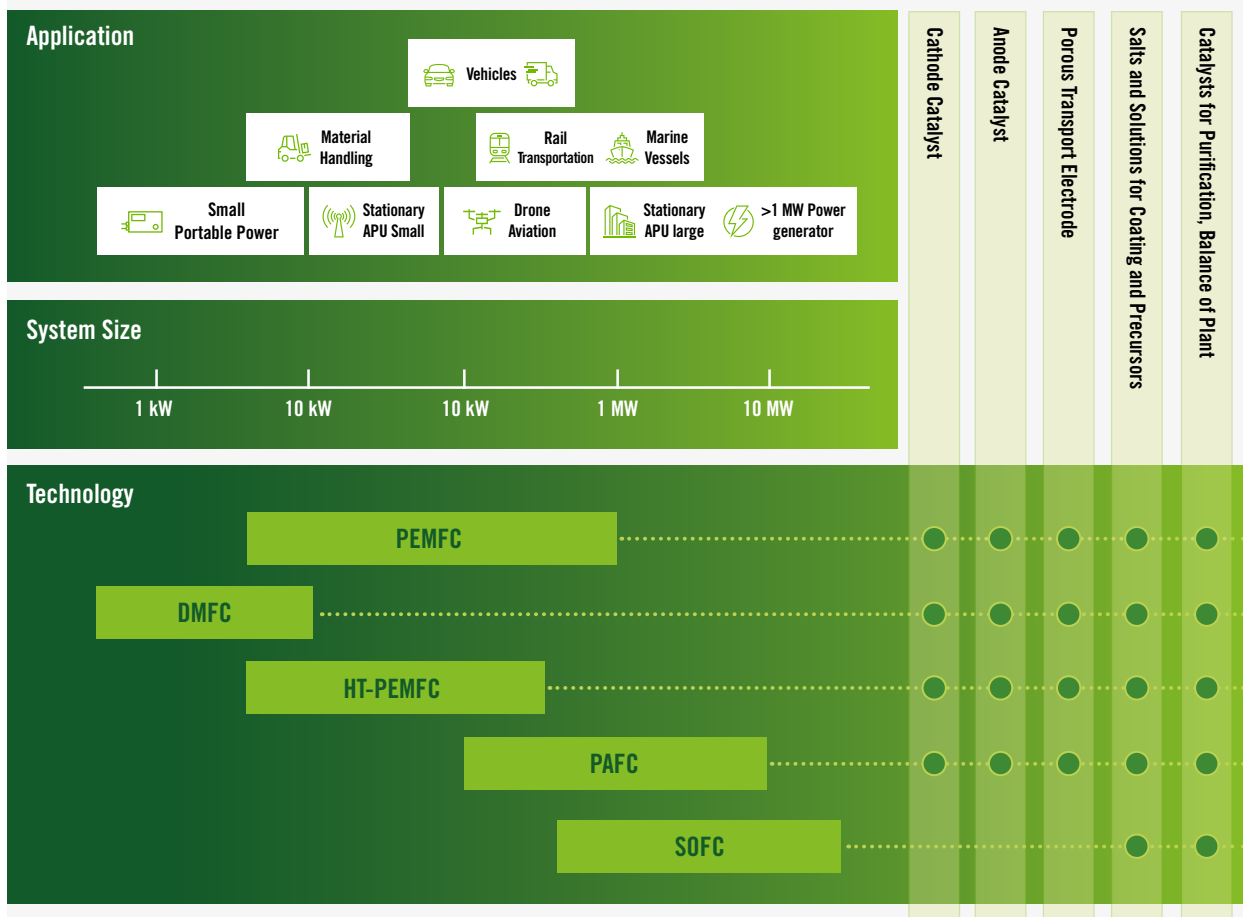
A large number of mature fuel cell technologies are already available to serve different use cases and size requirements for the generation of electricity from hydrogen and its derivatives. Each technology offers specific advantages and disadvantages for use cases broadly classified as stationary, transport, and portable fuel cell applications.

More specifically, fuel cell applications in passenger vehicles, long-haul trucks, rail and marine transport, and stationary APUs of various sizes. These applications have different requirements regarding load fluctuations, system size, feed gases (hydrogen,

hydrocarbons, and nitrogen-hydrogen compounds), and tolerated fuel impurities. These requirements can be achieved through dedicated engineering within a fuel cell technology, i.e., PEMFC, or by choosing a dedicated fuel cell type that is intrinsically better suited to handle aspects such as impurities, or the use of hydrogen derivatives as fuel.

Heraeus offers electrocatalysts for low and intermediate temperature fuel cells (DMFC, PEMFC, HT-PEMFC, and PAFC) and provides reformer catalysts and protective coatings for high temperature Solid Oxide Fuel Cells (SOFC).

Fuel Cells applications and technologies



The World of Fuel Cell Catalysts

Heraeus provides catalyst tailored to your application.
As the fuel cell technologies expand into new applications, so do we!

Heavy Duty Vehicles

- Long operating lifespan of up to 30,000 hours
- Robustness against frequent start-stop cycles, freeze start capabilities, and severe vibration
- Efficiency optimized for low total cost of ownership

Stationary Applications

- Long lifetime with more than 40,000 operating hours
- Constant output with high cost-efficiency or fast-start capability
- Low-maintenance, long-term operation

Planes

- High gravimetric energy density
- High power requirements, high voltage
- Reliable, designed to meet regulatory approval requirements

Drones

- Long range at low weight and high power
- Several hours of operation
- Combination with small batteries for demand peaks



Passenger Vehicles

- Highly active electrocatalysts for low weight and high power density
- Sub-freezing cold start capabilities
- Cost efficiency to compete with BEVs

Marine

- Scalability and modularity for flexible integration into different vessel sizes
- Different types of fuel cells for different vessel types
- Options for combination with a reformer stage to enable the use of synthetic hydrocarbons

Railway

- Long lifetime with more than 40,000 operating hours
- Frequent system start with constant fuel cell output
- High economic efficiency

Material Handling Vehicles

- Fast refueling times
- Tolerance of frequent stop-and-go operation and heavy lifting
- Options for combination with existing lead-acid batteries

* This infographic is referring to advantages and specific requirements in fuel cells used in above applications.

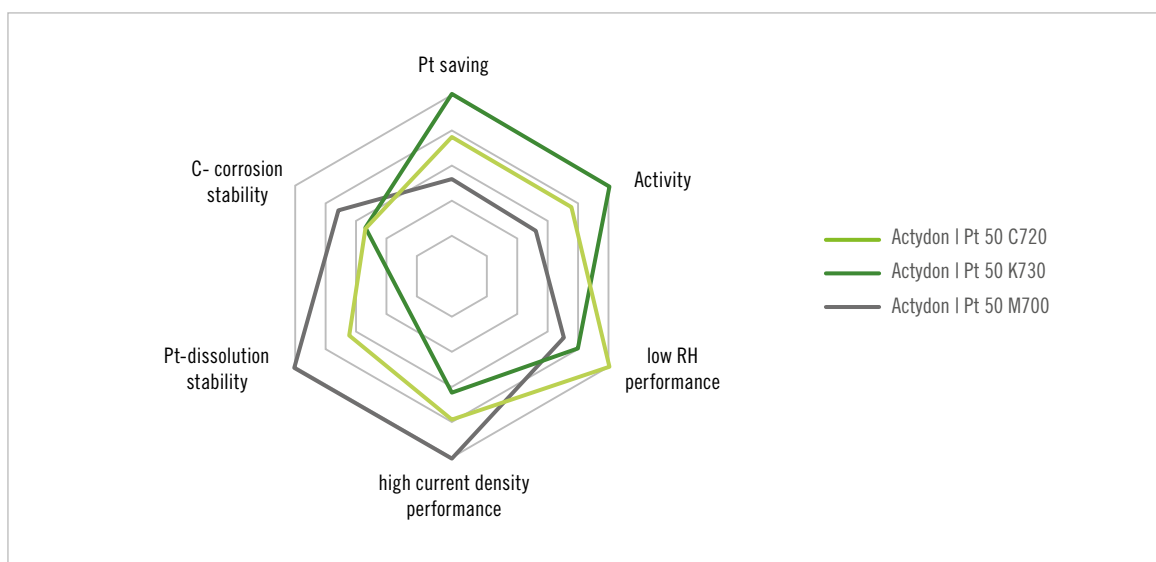
PEMFC Proton Exchange Membrane Fuel Cells

The Proton Exchange Membrane Fuel Cell (PEMFC) is the most deployed fuel cell type. As this fuel cell type that has been adapted for a wide range of use cases, Heraeus offers a variety of different catalysts for both the cathode and anode to meet the individual requirements of these use cases.

Cathode

Actydon I Pt PEMFC cathode materials are optimized for high performance, high durability, or specific operating conditions, i.e., operation at low relative humidity. Together with our customers, we balance platinum loading with the required durability and performance requirements.

	Description	Pt Content (wt%)	ECSA [$\text{m}^2/\text{g}_{\text{Pt}}$]	Crystallite size [nm]
Actydon I Pt 50 C720	50 wt% Pt on high surface area carbon	46 – 51	> 75	2.0 – 3.6
Actydon I Pt 50 K730	PtCo alloy catalyst on high surface area carbon	44 – 47	> 70	4.0 – 5.0
Actydon I Pt 50 M700	50 wt% Pt on high surface area carbon High durability option	48 – 52	> 70	4.0 – 5.0



Fuel Cell catalyst optimized for your use case!

Heraeus works with our customers to provide solutions tailored for their application. We are happy to receive functional requirements that differ from the established standards for mobility applications. If such requirements are not fully established, we support our customers in requirements engineering to derive the needed properties and provide the most suitable catalyst option.

The use of digital twins for the end application enables us – with our partner companies – to generate input for our catalyst development and quickly simulate the response of catalysts at the system level.

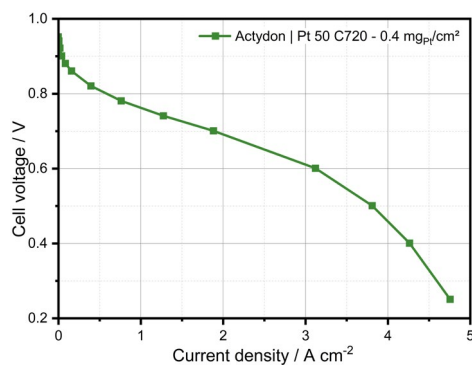
Actydon I Pt 50 C720

The PEMFC cathode catalyst Actydon I Pt 50 C720 is Heraeus' answer for total-cost-of-ownership (TCO)-optimized operation of PEMFC heavy-duty vehicles, such as long-haul trucks. The catalyst allows for robust operation with low sensitivity to relative humidity (RH) changes and excellent performance under low RH conditions.

Combined with high activity and high stability, the material is recommended for mobility applications, stationary applications, and next-gen applications that rely on long operating times, flexible operating conditions, and high efficiency, especially at intermediate current densities. The product family also includes Actydon I Pt 70 C720 with 70 wt% Pt loading specifically designed for aviation applications.

Actydon I Pt 50 C720 - Performance

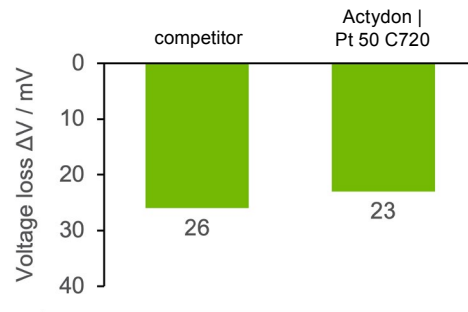
(80 °C, 100% RH; p = 2 bara)



Actydon I Pt 50 C720: Polarisation curve recorded in a Baltic qCF 12 high Amp for a CCM with cathode: Actydon I Pt 50 C720 0.4 mg_{Pt}/cm²; Membrane: Gore M788.12; and anode: Actydon I Pt 40 C100 0.1 mg_{Pt}/cm².

Actydon I Pt 50 C720 - Stability

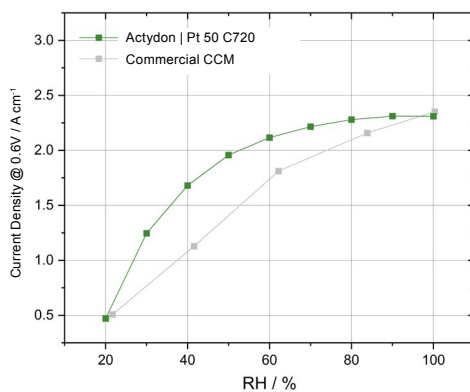
(DOE AST P.1 80 °C; 100% RH 0.6 V (3s)- 0.95 V (3s))



Actydon I Pt 50 C720: Pt- dissolution AST DOE P.1 recorded in serpentine flow field cell. Voltage loss@ 0.8 A/cm² after 30,000 cycles. Comparison of Actydon I Pt 50 C720 to competitor Pt/C at identical Pt loading. Cathode: Actydon I Pt 50 C720 0.4 mg_{Pt}/cm²; Membrane: Gore M788.12; anode: Actydon I Pt 40 C100 0.1 mg_{Pt}/cm².

Actydon I Pt 50 C720 - RH Sensitivity

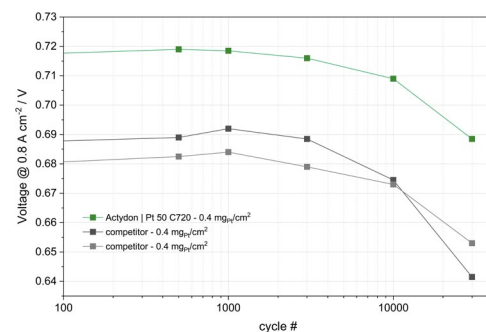
(80 °C, variable RH, p = 2 bara, 0.6 V)



Actydon I Pt 50 C720: Polarisation curve recorded in a Baltic qCF 12 high Amp for a CCM with cathode: Actydon I Pt 50 C720 0.4 mg_{Pt}/cm²; Membrane: Gore M788.12; and anode: Actydon I Pt 40 C100 0.1 mg_{Pt}/cm².

Actydon I Pt 50 C720 - Stability

(DOE AST P.1 80 °C; 100% RH 0.6 V (3s)- 0.95 V (3s))



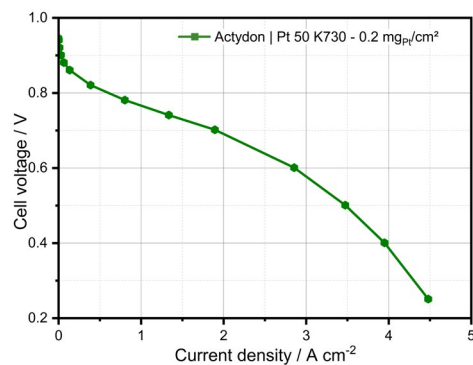
Actydon I Pt 50 C720: Pt- dissolution AST DOE P.1 recorded in serpentine flow field cell. Voltage loss@ 0.8 A/cm² evolution over cycle number: Actydon I Pt 50 C720 0.4 mg_{Pt}/cm²; Membrane: Gore M788.12; anode: Actydon I Pt 40 C100 0.1 mg_{Pt}/cm². Comparison to 2 different competitor cathode catalysts.

Actydon I Pt 50 K730

The PEMFC cathode catalyst Actydon I Pt 50 K730 is Heraeus' PtCo alloy on carbon catalyst developed for low platinum and high performance targets of passenger and light-duty vehicles with a high number of controlled load changes. The materials is also suited for stationary and marine applications with a focus on fuel efficiency, or aviation applications with high power density requirements.

Actydon I Pt 50 K730 - Performance

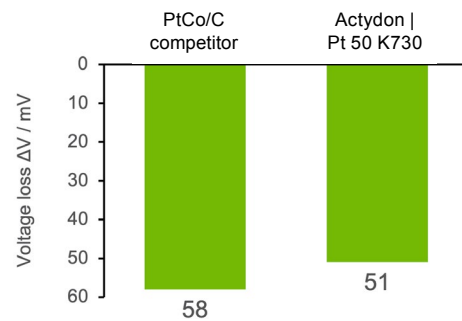
(80°C, 100% RH; p = 2 bara)



Actydon I Pt 50 K730: Polarisation curve recorded in a Baltic qcf 12 high Amp for a CCM with cathode: Actydon I Pt 50 C720 0.4 mg_{Pt}/cm²; Membrane: Gore M788.12; and anode: Actydon I Pt 40 C100 0.1 mg_{Pt}/cm².

Actydon I Pt 50 K730 - Stability

(DOE AST P.1 80 °C; 100% RH 0.6 V (3s)- 0.95 V (3s))



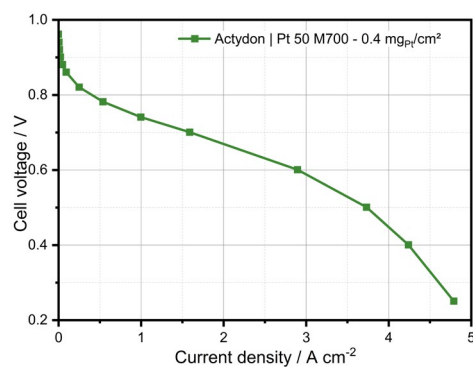
Actydon I Pt 50 K730: DOE AST P.1 recorded in serpentine flow field cell. Voltage loss@ 0.8 A/cm² after 30,000 cycles. Comparison of Actydon I Pt 50 K730 to competitor PtCo/C at identical Pt loading. Cathode: Actydon I Pt 50 K730 0.2 mg_{Pt}/cm²; Membrane: Gore M788.12; anode: Actydon I Pt 40 C100 0.1 mg_{Pt}/cm².

Actydon I Pt 50 M700

The PEMFC cathode catalyst Actydon I Pt 50 M700 is Heraeus' Pt on carbon catalyst developed for challenging applications with fluctuating loads, high current densities and high durability requirements. Heavy-duty vehicles, trains, etc., as well as systems with little load mitigation through batteries, profit from Heraeus' high-durability option.

Actydon I Pt 50 M700 - Performance

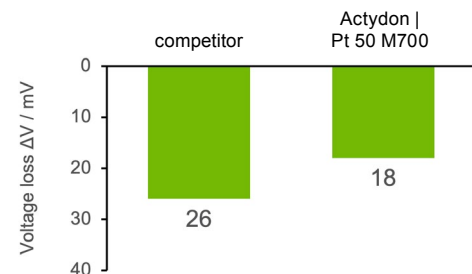
(80 °C, 100% RH; p = 2 bara)



Actydon I Pt 50 M700: Polarisation curve recorded in a Baltic qcf 12 high Amp for a CCM with cathode: Actydon I Pt 50 C720 0.4 mg_{Pt}/cm²; Membrane: Gore M788.12; and anode: Actydon I Pt 40 C100 0.1 mg_{Pt}/cm².

Actydon I Pt 50 M700 - Stability

(DOE AST P.1 80 °C; 100% RH 0.6 V (3s)- 0.95 V (3s))

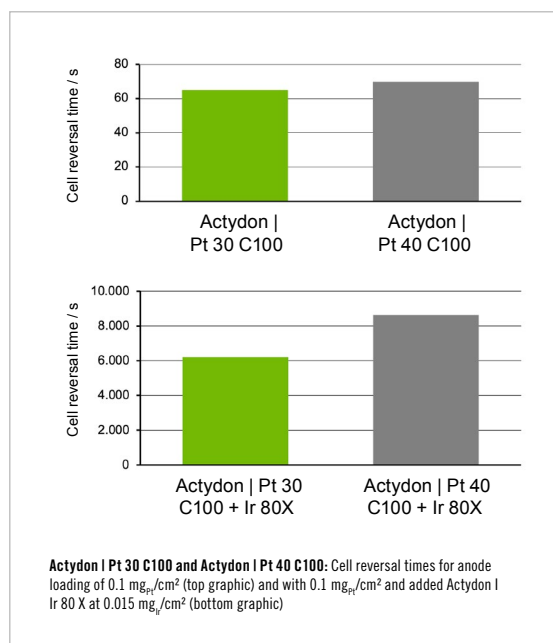
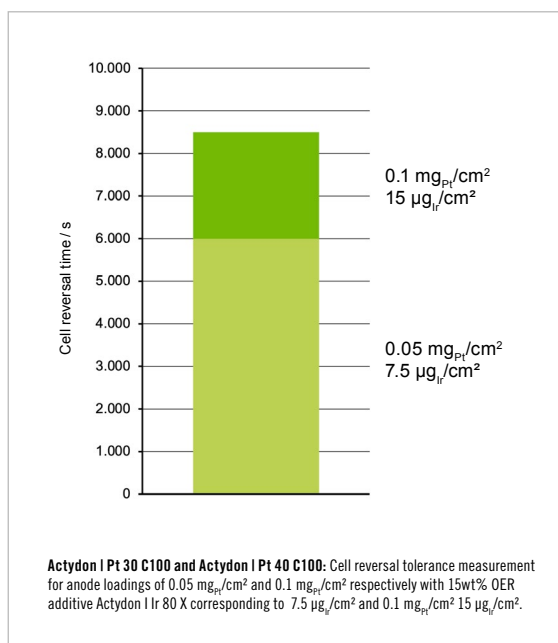


Actydon I Pt 50 K730: DOE AST P.1 recorded in serpentine flow field cell. Voltage loss@ 0.8 A/cm² after 30,000 cycles. Comparison of Actydon I Pt 50 M700 to competitor Pt/C at identical Pt loading. Cathode: Actydon I Pt 50 M700 0.4 mg_{Pt}/cm²; Membrane: Gore M788.12; anode: Actydon I Pt 40 C100 0.1 mg_{Pt}/cm².

Anode

Actydon I Pt PEMFC anode materials have an intrinsically high tolerance to hydrogen starvation and cell reversal due to a highly graphitized support material. With a minimal amount of Actydon I Ir 80 XSP OER additives the cell reversal tolerance can be increased even more. Reducing the overall PGM loading of the anode is enabled through the combination of Actydon catalysts. A reduction of 50% PGM loading still retain 75% of the cell reversal tolerance time.

	Description	Pt Content [wt%]	ECSA [$\text{m}^2/\text{g}_{\text{Pt}}$]	Cell reversal tolerance [s]	Cell reversal tolerance [s] incl. additive Actydon I Ir 80 XSP @ $15 \mu\text{g}_{\text{Ir}}/\text{cm}^2$
Actydon I Pt 30 C100	30 wt% Pt on highly graphitized carbon for high corrosion stability.	28 – 31	40 – 56	> 65	6000
Actydon I Pt 40 C100	40 wt% Pt on highly graphitized carbon for high corrosion stability.	37 – 42	40 – 52	> 70	8500



DMFC | Direct Methanol Fuel Cells

Direct Methanol Fuel Cells (DMFC) are an advanced type of fuel cell used in portable devices and small-scale stationary power supplies. They are directly fed with easy-to-store-and-transport methanol or methanol-water mixtures. Heraeus offers the specific platinum-ruthenium electrocatalysts used on the fuel cell anode side and efficient cathode catalysts for non-pressurized applications.

		Description	Pt Content [wt%]	ECSA [$\text{m}^2/\text{g}_{\text{Pt}}$]	Crystallite size [nm]
Actydon I Pt 50 C700	Cathode	50 wt% Pt on high surface area carbon	48 – 52	> 75	2.2 – 3.0
Actydon I Pt 30 Ru C700	Anode	PtRu alloy on high surface area carbon (30 wt% Pt)	47	~ 35	3.8 – 4.2
Actydon I Pt 30 Ru C705	Anode	PtRu alloy on high porosity high surface area carbon (30 wt% Pt)	47	~ 40	3.3 – 3.6

PAFC	Phosphoric Acid Fuel Cells and
HT-PEMFC	High Temperature Polymer Electrolyte Membrane Fuel Cells

Phosphoric Acid Fuel Cells and so-called High-Temperature Polymer Electrolyte Fuel Cells both use phosphoric acid as an electrolyte and operate at temperature between 160 °C and 200 °C. The systems are often operated with impure reformat generated from easy-to-store hydrocarbons (methanol, methane, formic acid, etc.) rather than with purified, pressurized hydrogen.

The increased temperature compared with PEMFC, together with the use of phosphoric acid, necessitates the use of specific catalyst materials, that are tolerant to catalyst poisoning by phosphoric acid and stable at the operating temperatures. Heraeus offers specific platinum-alloy catalysts on carbon for the cathode side and anode catalysts that can further increase the systems' tolerance to fuel impurities.

		Description	Pt Content [wt%]	ECSA [m ² /g _{Pt}]	Crystallite size [nm]
Actydon I Pt 50 C700	Anode	50 wt% Pt on high surface area carbon	48 – 52	> 75	2.1 – 3.1
Actydon I Pt 50 C720	Anode	50 wt% Pt on high surface area carbon	46 – 51	> 75	2.5 – 3.5
Actydon I Pt 50 K730	Cathode	PtCo alloy catalyst on high surface area carbon	44 – 47	> 45	4.0 – 5.0



All rights reserved. As of September 2026.

Heraeus Precious Metals GmbH & Co. KG
Heraeusstraße 12 – 14
63450 Hanau, Germany
hydrogen.systems@heraeus.com



heraeus.pm/en-hydrogen-systems