

# Platings for hydrogen production

Optimised technologies



HOLZAPFEL GROUP  
clever coating.



# The age of hydrogen

**Decades of development and plating expertise from Holzapfel Group**

The climate change discussion has placed even greater focus on the topic of sustainability. Hydrogen is the right answer to many of the questions surrounding the energy and raw materials transition, as it will play a key role as a source of energy and chemical raw material when it comes to achieving our climate protection targets. However, hydrogen can only be successfully deployed if the systems for generating, storing, transporting and using this product can be optimised, i.e. if it can become more energy-efficient, stable, safe and economical. **But we need to start paving the way today, as now is the time to optimise technologies, define and set standards, and develop the corresponding infrastructures.**

Apart from research and development, engineering services and unit construction, surface technology is also playing a vital part in making hydrogen-based technologies fit for the future. By developing the corresponding functional layers, surface technology can provide the parts and components used in hydrogen technology with new properties - such as adding protective functions that make them more durable, energy effective and efficient.

# Know-how and objectives

## Electroplating methods for electrodes

When it comes to electroplating the electrodes used in alkaline water electrolysis technology, we already have more than 20 years of experience at the Sinn location, coating thousands of square metres of component surfaces during that time. Together with Hydrotechnik Karlsruhe, we can draw on 48 years of expertise in water electrolysis, including projects such as the first alkaline electrolyser built for the Aswan Dam in Egypt. Our research and systems engineering know-how, coupled with the experience of an industrial high-volume plating specialist for functional surfaces supplying the automotive industry, makes us an extremely competent partner in terms of coating technologies.

In collaboration with various institutes, we are currently developing the next generation of surface treatments and joining methods, including a specialised process for coating activated cathodes that will enable us to manufacture complete electrode packages going forward.

Specific objectives for the plating process include enhancing efficiency in order to save energy by improving the catalytic effect of the various coatings.

Moreover, the surfaces of the active electrodes needed to produce hydrogen are enlarged by means of highly specialized deposition and bath management techniques, which has the positive impact of reducing degradation, thus ensuring the long-term stability of the functional layers. The production of these electroplated layers does not create any mechanical deformation contrary to the objective of the zero-gap cell design.

## Solutions for sustainable and efficient platings for hydrogen technology

- Efficiency improvement of the catalytic layers in order to save energy
- Effective reduction of both material and production costs
- Solutions for scalable processes
- Many years of competence in developing innovative plating solutions for various fields of applications
- More than 20 years of experience with platings for hydrogen technology at our plant in Sinn
- Both stack assembly and testing

## Components

As an industrial service provider, we are well equipped to electroplate the following components with our processes:

- Electrodes (anodes, cathodes)
- Bipolar plates
- End plates
- Cell frames and other water-bearing components

We also manufacture, assemble and complete entire packages of electrodes for your needs.

# Future technology hydrogen

## The Holzapfel Group's expertise with hydrogen

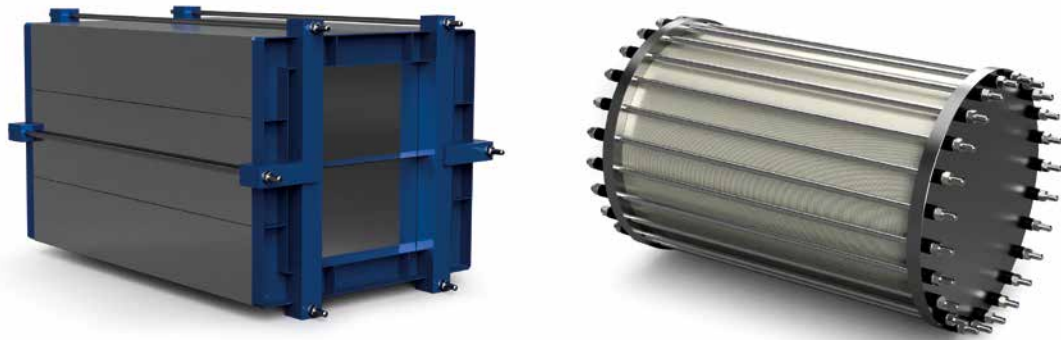
From our point of view as a surface plating specialist, one of the main challenges over the next few years will be to take the step towards the deformation-free, large-scale, catalytically active electroplating of anodes and cathodes based on suitable materials and processes.

Here we support you with well-founded knowledge of plating concepts for electrode packages and components of alkaline electrolyzers. In addition, we have been operating a plating plant for electrodes in serial production since 2005, and cell frames up to dimensions of 2,300 x 2,000 mm.



### History and projects completed:

- From 1965 to 1995, Hydrotechnik developed a special nickel-based electroplating that has been used in more than 400 electrolyzers.
- 288 electrolyzers with electrodes featuring activated NiS coating were produced for the Aswan Dam project in Egypt. (completion in 1960, installation in 1963)
- In 1982, Hydrotechnik coated electrodes with nickel-zinc for the first time in cooperation with KfA Jülich.
- In 1987, a new type of electrolyser fitted with nickel-zinc electrodes was developed for a Hysolar project
- The first industrial electrolyser with plasma spray coating, was developed in 1997 in collaboration with a highly regarded institute.
- From 1999 to 2003, various electrolyzers featuring VPS (vacuum plasma spraying) technology were developed.
- Joint project together with Fraunhofer IPA to develop functional electroplated surfaces (year 2000).
- Project ecoPtG in 2015: Low-cost electrolyser using automotive components and highly efficient electroplated electrodes developed.
- New electroplating line established as a pilot plant in 2017.



### Projects completed by the Holzapfel Group:

- We completed and assembled electrode packages for alkaline electrolyzers for a manufacturer of electrolysis equipment, each with a capacity of 2 MW. The electrodes and bipolar plates were coated prior to assembly, followed by the cell frames.
- Since 2014, we have been plating anodes, cathodes and bipolar plates in large volumes for a European manufacturer of electrolyzers.
- We have also been plating bipolar plates in series production for another internationally operating electrolysis manufacturer since 2020.
- From 2015 to 2018, we developed electrode packages for a P2G project funded by the German Federal Ministry of Economics and Technology in close cooperation with an institute.
- Together with various partners and institutes, we have manufactured a broad range of equipment for both testing purposes and electrode packages (up to 2,700 cm<sup>2</sup> of electrode surface).
- We also participate as partners in national and international research projects as well as developmental real laboratories.



Plant for the coating of components for water electrolysis



# Performance and energy consumption

## The electrode package

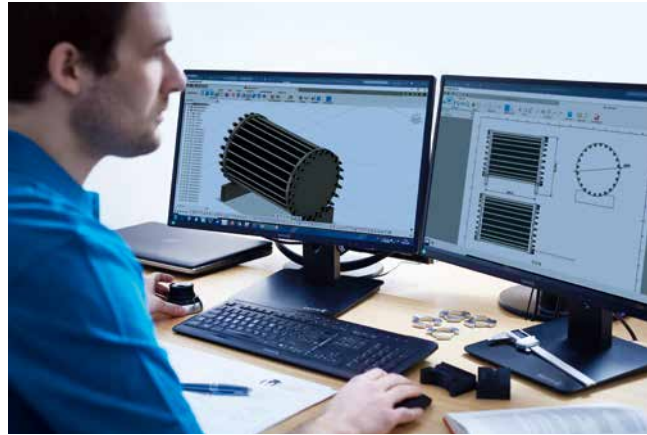
A significant component of the electrolyzer are the electrode-packages (EPs). These are used multiple times and stacked within the system. These parts play an important role in defining overall efficiency and energy consumption of the hydrogen production.

The Holzapfel electrode package can be customised according to individual, specific dimensions. The spacing between the electrodes and the bipolar plate can be specifically adjusted to the customer's construction, also Zero-gap cell design can be realised. We also developed a method to connect the electrode packages (anode - bipolar plate - cathode) coherent and gas tight with each other. The risk of gas impurities due to leaking screwed connections in the stack is omitted.



### Production of complete electrode packages

- Customised engineering
- Production of electrodes and bipolar plates
- Coherent connections
- Assembly of complete electrode packages with measurements according to customer specifications



# Research and development

## Competence in perfection

Our chemistry and materials laboratory is fitted with state-of-the-art analytical equipment that enables us to research and develop new surface treatment processes for hydrogen technologies.

Not only can we permanently monitor plants and coating processes, we can also develop them on a continuous basis. State-of-the-art analytical methods such as a scanning electron microscope with an EDX analysis system or confocal microscopy enable us, for example, to perform extremely detailed layer examinations in the course of development processes, including high-precision examinations of the layer composition and layer properties. These microscopic analytical instruments make it possible to examine surfaces with great precision, including highly magnified in-depth analyses of their microstructures. We can also reproduce even the finest contours with outstanding accuracy. These detailed examinations and analyses help us to qualitatively and quantitatively describe the structure of the metal and explore the interactions between the coating and the base material. We then use the knowledge thus gained to optimise our coating processes and develop the required coating characteristics. When integrated in the development process at an early stage, these highly detailed analyses can also provide us with information that enables us to adapt our designs and materials.

- Comprehensive range of measurement and analysis technology
- Scanning electron microscope for surface analysis (with EDX analysis system)
- Confocal microscope
- Electrolysis test rig for validating the deposited layers on a scale of up to 2,700 cm<sup>2</sup>

## Pilot plant for testing and developing coatings

We have a pilot plant capable of handling substrates up to 2,700 cm<sup>2</sup> in size, where we electroplate electrode surfaces with various specially developed alloys and plating. Here we draw on experience gained from an earlier project that focused on developing electrode packages. We are currently engaged in the further development of coating processes and plant technology, with the focus on constructing and commissioning a large-scale industrial plant for electrode plating.

### Surface treatments for hydrogen technology:

- Nickel sulfamate
- Electroless Nickel
- Galvanic nickel
- Silver
- Tin
- Combined surface treatments

