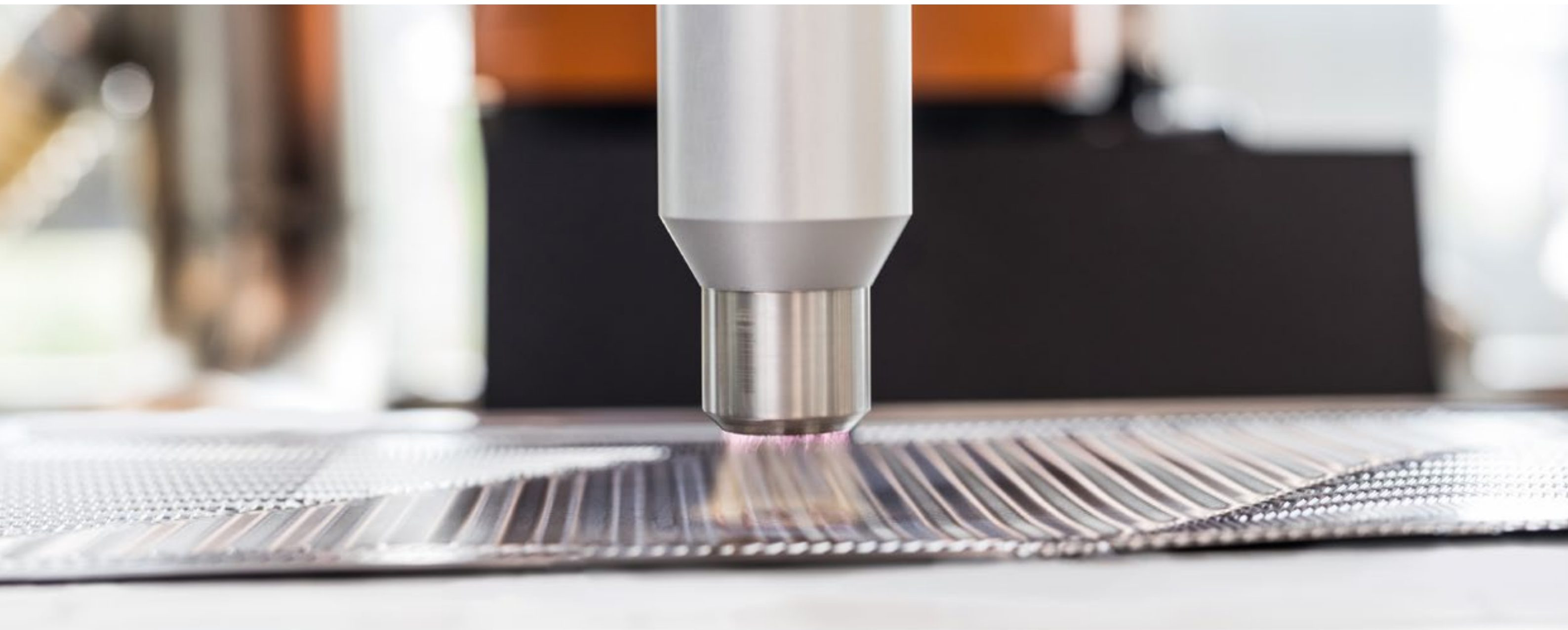


APPLICATION INFORMATION

Robust and High-Performance Fuel Cells

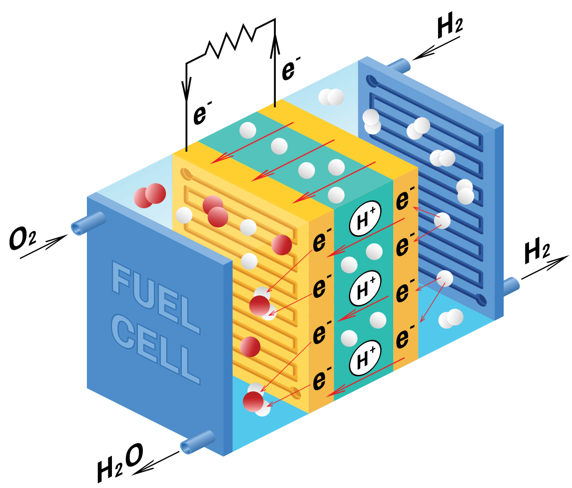
Cleaning, activation and coating of bipolar plates with Openair-Plasma®

The fuel cell is considered to play an important role in meeting the challenges of climate change due to its reputation as a green technology. In combination with a hydrogen tank and a battery, fuel cells can be used for modern transportation. Considering the mechanical stability requirements and climatic conditions that modern cars have to cope with worldwide, the use of fuel cells in motor vehicles thus poses special challenges to the robustness of the cell system.

Here, Openair-Plasma® an improve resistance to environmental influences, provide additional safety for the entire fuel cell system and help reduce the overall weight of the system. Furthermore, Plasmatreat supports the lightweight construction and battery manufacturing process in order to optimize the surface properties according to the requirements here as well.

Design of a fuel cell

The assembly of the fuel cell element begins with the stacking process. Stacking is the process by which the various elements of the fuel cell are assembled to form the defined total capacity of the fuel cell. A single fuel cell element consists of two bipolar plates, which are equipped with the membrane electrode. In general, either purely metallic bipolar plates or graphite plates with a polymer matrix are used. During the exothermic chemical reaction, the charges generated at the cathode and anode discharge. Inside the bipolar plates there is a cooling medium (glycol-water mixture) to dissipate the heat of reaction. Due to the required sealing functions against media (cooling medium water/glycol) and gases (hydrogen and oxygen), there are four different plasma applications in the cell.



Design of a fuel cell.

Fields of Application for Openair-Plasma®

Cleaning and activation before bonding

In today's manufacturing process of metallic bipolar plates, release agents are used which have to be cleaned off for the subsequent processes. Here, Openair- Plasma® offers dry ultra-fine cleaning with atmospheric plasma, which can be integrated inline into the process.

The downstream process can then easily use different bonding and sealing systems, be it a liquid seal or a solid seal system. In the case of liquid sealants, which are often UV-curing adhesives, activation with Openair- Plasma® also guarantees good adhesion and thus speeds up the production process. Openair-Plasma® expands the possible choice of adhesives here. This can lead to a significant cost reduction in the fuel cell assembly process.

Long-term hydrophilicity through activation and coating

Long-term hydrophilicity is an important function of bipolar plates. It determines how efficient the fuel cell performs over its lifetime. If the hydrophilicity decreases over the lifetime, the overall efficiency of the fuel cell is reduced. By the activation with Openair-Plasma®, on the other hand, long-term hydrophilicity can be realized.

The effect of plasma can be increased even further: With the aid of PlasmaPlus® technology, nanocoatings can be applied to the surface that are superhydrophilic, for example. A special jet head is used to inject an additional precursor tailored to the intended use into the plasma beam. With this coating, long-term hydrophilicity can also be achieved. In addition, the metallic bipolar plates can be covered with an AntiCorr® coating using the PlasmaPlus® process to protect them from corrosion and also improve contact resistance.

Optimization of hydrogen tanks by improving the adhesion of filaments

The main advantages of fuel cell vehicles are in particular the high mileage per charge, which in some cases already exceeds 800 km (500 mi) and the fast recharging speed, which is currently around 3 minutes. The key to further extending these advantages lies in improving the high-pressure container in which the hydrogen is stored on board of the vehicle. Currently, the most common hydrogen tank design, Type 4, consists of a hydrogen-containing liner and carbon fibers wrapped around the liner, which give the tank the necessary strength and rigidity against the external stresses and the internal fuel pressure - currently set by the EU at 70 MPa.

Higher mileage per load can be achieved by making the wall of the tank liner thinner and/or the construction of the tank stronger and more rigid. This would allow tank standards to be designed for even higher pressures at which the fuel is stored.

A thinner substrate requires an optimally designed winding pattern for the filaments. One problem that can occur when winding filaments is the displacement of the filament at the dome (curved section) of the tank. This is due to insufficient adhesion between the surface of the liner (in most cases made of plastics such as PA or PE) and the matrix material of the filaments, which is mainly thermoset epoxy.

Treating the surface of the substrate with Openair-Plasma® increases the surface energy to a level that provides sufficient adhesion to prevent such displacement. This higher adhesion can also accelerate filament winding, a process often considered a bottleneck in hydrogen tank manufacturing.

Fiber-matrix adhesion can be improved by applying a PlasmaPlus® coating to the fiber in the spinning process. This technology increases the density of the adhesion-promoting groups on the surface of the glass fibers and thus supports reactivity with the epoxy resins for a continuous and durable bond. In this way, fiber-matrix adhesion can be increased by up to 20%. This makes it possible to build even lighter and more cost-effective FRP components.

Hydrogen tank with filament winding

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