Influence of plasma-diffusion-based surface modifications on the corrosion behavior and the contact resistance of austenitic stainless steels

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Plasma nitriding of austenitic stainless steels to improve the tribological properties has been the subject of research for many years. The incorporation of atomic nitrogen leads to the formation of the so-called S-phase. This phase is characterized by a strong lattice distortion in the surface area and thus an increase in hardness. The formation and development of this phase influences other properties at the same time, such as corrosion behavior and interfacial contact resistance. For this reason, the combination of austenitic stainless steels and plasma diffusion treatment is gaining increasing attention in the research and development of bipolar plates. For example, one advantage is the economic alternative to other metals, such as titanium or nickel materials.

The properties of an untreated austenitic stainless steel do not fulfill the requirements for use as a bipolar plate. This is due to the chromium oxide passive layer, which causes the high corrosion resistance in an acidic environment, but at the same time leads to a high interfacial contact resistance due to its isolating properties.

Research shows a significant reduction in interfacial contact resistance and only minor changes in corrosion resistance for plasma diffusion treated austenitic steels compared to the untreated variants. It can be concluded from this that other mechanisms of corrosion protection apply to plasma diffusion treated steels than the electrically isolating passive layer alone. In order to provide a parallel improvement of both surface properties, a deeper understanding of the interactions between the treatment conditions, the microstructure and the chemical-structural as well as electrochemical properties of the s-phase is required.

Therefore, in the following project, different plasma diffusion processes will be correlated with the microstructure and the resulting properties. The focus is on:

- Variation of plasma diffusion treatment: process control, parameters and working gas (nitrogen and carbon).
- Determination of microstructural, electrochemical and electronic surface properties
- Integration of simulations to determine precipitation processes and phase formation
- Development of a model conception including the interactions