Steel for green hydrogen

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Abstract Expensive materials significantly limit the commercialization of green hydrogen production from water electrolysis. A key component, pure titanium, is used in porous transport layers and bipolar plates due to its excellent corrosion resistance at potentials above oxygen evolution. Additionally, titanium is often coated with noble metals like gold or platinum to reduce contact resistance and prevent oxidation, further driving up costs. In contrast, stainless steel is more affordable and widely used but faces challenges due to the conventional chromium-based passivation mechanism. This single-passivation mechanism leads to transpassive corrosion at around 1000 mV, which is insufficient for water oxidation.

Here, we present a solution with stainless steel that employs a sequential dual-passivation mechanism to enhance anti-corrosion properties. By combining chromium-based and manganese-based passivation, we achieve a high breakdown potential of ~1700 mV (saturated calomel electrode, SCE) in a 3.5 wt.% NaCl solution. The chromium-based layer protects at lower potentials (below ~720 mV SCE), while the manganese-based layer withstands higher potentials up to ~1700 mV SCE. This “sequential dual-passivation” strategy extends the passive region of stainless steel, making it a potential candidate for anodic materials in green hydrogen production through water electrolysis.