TRIPLE CONDUCTING OXIDE ELECTROCATALYSTS FOR EFFICIENT PRODUCTION OF GREEN HYDROGEN AT INDUSTRIALLY RELEVANT TEMPERATURES

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Protonic ceramic electrolysis cells (PCECs) when H2O electrolysis is involved), the steam electrolysis to its elements is the most extensively studied reaction system since it offers highly efficient storage of intermittent renewable electricity into hydrogen for later use in energy applications or chemical industry.[1] In PCEC, the steam splitting takes place at the anode (positrode) simultaneously with the oxygen evolution reaction while the molecular hydrogen is recovered at the cathodic electrode (negatrode) side:
Anode: 2H2O (g) ⟶ 4H+ + 4e - + O2 (1)
Cathode: 4H+ + 4e⁻ ⟶ 2H2 (2)
It is obvious that the choice of the anodic electrocatalyst (positrode) for the oxygen evolution reaction (OER) is critical and one o0f the main challenges for this system. Suitable materials should be triple conductors (H+ , O2-, e-), catalytically active for OER, adequately stable under steam and oxidizing atmospheres, as well as, their thermal expansion coefficient (TEC) values should be close to the ceramic electrolyte under reaction atmospheres (temperature, humidity etc.). So far, several types of oxide materials have been investigated with different types of perovskite oxides (POs) and misfit-layered oxides to have shown the optimum performance. [2,3] Herein, we explore different types of mixed ionic-(protons, oxygen ions) electronic conducting perovskites (e.g., PrNiCo-based - PNC) were developed, and modified through rational doping to vary its conductivity ratios and electrocatalytic activity. The anodic electrocatalysts were deposited on cathode (Ni-based) supported half-cells to be investigated through in-situ electrochemical impedance spectroscopy and linear scanning voltammeter. The electrochemical characterization results were supported by several physicochemical techniques (BET, XPS, SEM/EDX, TGA) and online gas-chromatography to elucidate further the reaction mechanism for steam oxidation to protons. An >80% faradaic efficiency of steam electrolysis was observed, while the doping strategy at the A-site seems beneficial for enhancing the electrocatalytic performance of the materials. The present results exemplify the potential of PCECs as solution for high efficient hydrogen production at the intermediate temperature range which may enable integration with industrial processes.

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