Synergistic Interaction of Au-Mo Modification on Ni/GDC for H_2O Electrolysis in SOECs

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ABSTRACT

High quality H_2 (~100% H_2) can be produced by the electrochemical conversion of H_2O to H_2 and O_2 through water electrolysis at low or high temperatures. Water electrolysis at temperatures above 500 °C, with steam, using Solid Oxide Electrolysis Cells (SOECs) is a promising and fast growing technology [1]. SOECs have identical configuration with Solid Oxide Fuel Cells (SOFCs) but reverse operation. The latter relation is quite advantageous compared to low temperature technologies, because SOECs can be built based on the significant SOFCs development, which has seen a significant research [2]. Specifically, novel modified Ni-based fuel electrodes are continuously being processed for fuel cell (H/Cs: Natural Gas, Biogas) and electrolysis (H_2O, CO_2 and H_2O+CO_2) applications with improved performance and stability of the state-of-the-art Ni-based electrodes [1].

The present study concerns the effect of Au-Mo modification on the electrochemical and physicochemical characteristics of Ni/GDC for H_2O electrolysis conditions in a single SOEC. Comparative electrocatalytic measurements with I-V curves and Electrochemical Impedance Spectra (EIS) analysis are presented in the range of 800-900 °C between electrolyte supported cells that comprise either a Ni/GDC or a 3wt.%Au-3wt.%Mo-Ni/GDC steam/hydrogen electrode, by applying different pH_2O/pH_2 ratios. Complementary physicochemical characterization was also performed both in the form of powders and as half cells with ex-situ and in-situ techniques, including specific redox stability measurements in the presence of H_2O.

Different structural and activity properties were observed for each cermet, where the cells comprising the Au-Mo modified electrodes exhibited better electrochemical performance. This improvement can be ascribed to the formation of a surface Ni-Au or Ni-Au-Mo solid solution [3, 4], which cause weaker interaction of H_2O and of the resulting adsorbed O_{ads} species with the modified cermet. The outcome is an electrode with a lower degree of surface oxidation and increased “three phase boundaries” length, where the charge transfer and electrode processes are enhanced for the H_2O electrolysis reaction [5].

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