Sulfur tolerance of Au – Mo – Ni/GDC SOFC anodes under various CH_4 Internal Steam Reforming conditions

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Abstract

Solid oxide fuel cells (SOFCs) are among the most promising energy systems as they produce electric power and heat with higher efficiency as well as lower noise and pollutant emissions than conventional heat engines. In addition, they are quite flexible concerning fuel feed, as they can use either hydrogen or carbon containing fuels. In view of the fact that natural gas, which contains CH_4 as its main component and sulphur compounds, is a key energy vector worldwide, operation of fuel cells under internal reforming of CH_4 in the presence of sulphur is crucial for improving the process economics [1]. So far, Ni-based cermet is the most popular anode in SOFC systems due to its low cost, ease of fabrication and relatively high electrochemical activity. However, Ni cermets consisting of Ni and YSZ ceramic (Ni-YSZ) experience severe degradation in fuels containing only a few ppm of H_2S, due to the high vulnerability of Ni to sulphur poisoning. Studies using Ni/GDC [2, 3] have shown that this composition might be a very good candidate for operating in the presence of H_2S, since the degradation in performance for the H_2 oxidation in H_2S-conataining H_2 fuels is substantially smaller compared to that on Ni/YSZ anodes [2, 3]. Along this direction, it was recently published [1, 4] that modification of NiO/GDC anode powder via deposition-precipitation of fine dispersed Au and/or Mo nano-particles resulted in a material with high tolerance to carbon formation and improved catalytic and electrocatalytic activity under carbon forming conditions, for the reaction of internal CH_4 steam reforming. The present work refers to a first series of obtained results on how Au and/or Mo addition, can affect the stability of modified Ni/GDC anodes for the reaction of internal CH_4 steam reforming in the presence of H_2S. Specifically, the results show that Ni/GDC is stable in the presence of 10 ppm H_2S, but only in the case where 100vol% of H_2 is the anode feed. In the case where CH_4 and H_2O (diluted in Helium carrier gas) comprise the anode feed, then at S/C = 2 or S/C = 0.13 the performance of Ni/GDC is severely deteriorated and the Au-Mo-Ni/GDC anode is best and the most stable.

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