MODIFIED Ni-BASED ELECTRO-CATALYSTS FOR DRY REFORMING OF METHANE AS POTENTIAL ELECTRODES FOR SOFCs

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Recycling biogas to produce syngas (H_2 + CO) through Dry Reforming of Methane (DRM) has currently attract resurgent interest. Biogas consists mainly of CH_4 (55-65%) and CO_2 (35-45%) and is widely produced by anaerobic fermentation of biomass [1]. DRM provides a feasible solution to eliminate greenhouse gases via production of useful chemicals and hydrocarbons.

Considering the DRM energy applications the produced syngas can be used as a fuel in high temperature solid oxide fuel cells (SOFCs) for electricity production or biogas can be directly fueled in the cell without the need of an external reformer (Internal Dry Reforming of Methane, IDRM), which simplifies the SOFC system and reduces the cost [2,3]. Specifically, during IDRM at temperatures higher than 800 ^oC, the catalytic Reverse Water Gas Shift (RWGS) reaction may run in parallel with electrocatalytic reactions, resulting in the consumption of valuable H_2. In addition, carbon deposition on the electrocatalyst surface due to CH_4 decomposition, which is favored at elevated temperatures ($\geq$ 700 ^oC), may also occur resulting in progressive electrocatalyst deactivation [4].

Ni-based ceramic-metal composites with Yttria Stabilized Zirconia (YSZ) and Gadolinia Doped Ceria (GDC) are widely used as electrocatalysts in SOFCs because of their activity and inexpensiveness. However, nickel catalyses the formation of carbon deposits from hydrocarbons and exhibits a tendency to agglomerate after prolonged operation [3,4]. The carbon tolerance and anti-sintering tendency of nickel and specifically of Ni/GDC can be enhanced, by dispersing trace amounts of transition noble (Rh, Pt, Pd, Ru, Au) or non-noble (Co, Cu, Mo, Fe) metal elements [3,5].

In this study the performance and coking resistance of Ni/GDC, 1 wt.% Au-Ni/GDC, 3 wt.% Au-Ni/GDC, 0.5 wt.% Fe-Ni/GDC, 2 wt.% Fe-Ni/GDC, 3 wt.% Au-0.4 wt.% Mo-Ni/GDC and 3 wt.% Au-0.5 wt.% Fe-Ni/GDC electrocatalysts were studied in the form of half-electrolyte supported cells, at open circuit potential conditions, under CO_2 reforming of CH_4 in single SOFCs, at 750-900 ^oC. The aim was to elucidate their catalytic activity towards the consumption of CH_4, CO_2, the production of H_2, H_2O, CO and the production of carbon, under a biogas fuel mixture of CH_4/CO_2=1. The catalytic-kinetic measurements were carried out for a cell with Ni/GDC, under differential conditions, at various CH_4 and CO_2 partial pressures. The samples were also physicochemically characterized including measurements for the catalytic dissociation of CH_4 and CO_2.

Keywords: Solid Oxide Fuel Cells (SOFCs), Dry Reforming of Methane (DRM), Biogas, Ni-based electrodes, Open Circuit Conditions

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