Direct utilization of bio-fuels in sustainable solid oxide fuel cells: Development of Perovskite Oxides as Electrode Materials

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The goal of this study is to develop a new generation solid oxide fuel cell based on advanced ceramic materials for the direct utilization of biofuels (bio-ethanol, glycerol, bio-gas) to reduce the complexity of the balance-of-plant and produce electrical power and heat with high overall efficiency. Biofuels are rich in hydrocarbons and CO_2, and typically contain some sulphur compounds and other contaminants. Then, it is necessary to develop an exsolved perovskite catalytic pre-layer used at the anode to mitigate carbon deposition and anode poisoning. On the other hand, high temperature solid oxide fuel cells have shown significant potential as a viable solution for power production. Besides very good catalytic performance and high electron conductivity of SOFC operating temperatures, the Ni-YSZ anode has the propensity to produce carbon as side product. Therefore, the limited susceptibility of Ni-YSZ anode to carbon formation must be compensated by suitable removal methods. This work has been focused on the preparation of new materials for anode composition used as pre-layer, in order to avoid the carbon deposition or oxidized the formed solid carbon. Our previous works suggest that CeO_2 is an interesting catalyst for the soot oxidation, thanks to its unique features: it can participate to the oxidation cycle via a redox-type mechanism and may exhibit high oxygen storage capacity (OSC) (Piumetti, 2015). Thanks to these interesting properties, CeO_2 was studied as possible candidate for anode SOFC. This material was synthesized via the solution combustion synthesis (SCS) (Jain, 1981), impregnated with 7 wt.% of Ni and then, it was tested for the methane dry reforming. The results demonstrated interesting conversion of CH_4 and CO_2 at 800 °C, respectively about 48 and 75 %. Moreover, another set of samples were prepared: La-based perovskite. As a result, these systems are suitable candidate for anode SOFC material since they are excellent sulfur and coking tolerant (Cao, 2019). Moreover, La-Sr-Fe-Ti perovskite was synthesized by means of the chelate complex route method (Mascotto, 2019) and then the sample was impregnated with 7 wt.% of Ni. This sample was tested for the ethanol ATR. The results demonstrated that the ATR of ethanol reached the complete conversion at 600 °C and high H_2 selectivity (70%). In this context, on-going activities are focusing in La-Ce-based perovskite with the aim of enhance tolerance (S, C) and selectivity utilizing renewable fuels.

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