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BIMETALLIC ELECTROCATALYSTS – A NOVEL APPROACH FOR SOLID OXIDE CELL FUEL ELECTRODES

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Conventional Nickel Yttria-doped Zirconia cermet (Ni/YSZ) fuel electrodes for solid oxide cells are susceptible to degradation due to redox cycling, coking from carbon accumulation and poisoning by impurities such as sulphur in the fuel. Donor-doped $SrTiO_3$, like Nb-doped $SrTiO_3$ (STN), are promising candidates to overcome some of these limitations. However, due to the low ionic conductivity and poor electrocatalytic activity, STN require an electrocatalyst infiltration and the introduction of ionic conductivity in order to become effective electrodes in solid oxide cells (SOCs) applications. On-going separate studies associated with this project has indicated that STN/YSZ fuel electrodes infiltrated with the transition metals, Ni, Co and Fe, have similar electrocatalytic activity as that of the state of the art Ni/YSZ cermet electrodes. Furthermore, the studies also shows that Ni, Co, and Fe have different properties in the different gas atmospheres and hence it is of interest to combine these properties to further increase the overall performance and stability of the SOC fuel electrodes.

In this work, we report the first results from combining the three transition metals, Ni, Co and Fe, by infiltration alongside gadolinium doped ceria (CGO), into STN/YSZ symmetrical cells. All combinations of Ni, Co, and Fe were investigated, since each metal have desirable properties that would benefit the performance. The CGO is mainly infiltrated to extend the triple phase boundary (TPB), but it will also add to the overall electrocatalytic activity. The infiltrated cells were analyzed using electrochemical impedance spectroscopy at different temperatures and in different atmospheres, 4% H_2O/H_2, 50% H_2O/H_2, 80% H_2O/H_2, and 50% CO_2/CO. In addition, structural analysis was performed using scanning electron microscopy, which was combined with elemental analysis by energy dispersive x-ray spectroscopy. Furthermore, the electrocatalytic activity was enhanced by the coupling of transition metal catalysts particles. Polarization resistances down to 0.10 Ωcm^2, 0.13 Ωcm^2, and 0.52 Ωcm^2 was found for the Co-Fe-CGO, Co-Ni-CGO, and Ni-Fe-CGO infiltrated cells, respectively, at 850°C in 50% H_2O/H_2. Additionally, the temperature dependence of the polarization resistance was used to estimate the activation energy and the pre-exponential factor of the electrocatalytic reaction.