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Publication date:
2017

Document Version
Publisher's PDF, also known as Version of record

Screening the electrochemical activity of transition metal nanoparticles for SOFC anode infiltration

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Solid oxide fuel cells (SOFCs) are high temperature electrochemical devices that convert the energy released by a chemical reaction directly into electrical energy. Conventional SOFCs use a Nickel Yttria-doped Zirconia cermet (Ni/YSZ) as anodes. These nickel-based SOFC anodes are effective electrocatalysts for simple fuels such as H_2 or natural gas, but they are also susceptible to degradation due to redox cycling, coking from carbon accumulation and poisoning by impurities such as sulphur in the fuel gas. Other materials such as donor-doped $SrTiO_3$, like Nb-doped $SrTiO_3$ (STN) are promising candidates to overcome some of these limitations, since these ceramic perovskites are tolerant to carbon, and sulphur containing atmospheres, have a high electronic conductivity and are highly redox stable. However, STN is a very poor electrocatalyst for fuel oxidation and therefore STN must be infiltrated with electrocatalysts in order to become effective electrodes in SOFC applications.

In this work, we report the first steps in a screening process, where the electrocatalytic activities of some transition metals like Ni, Co, Mo, Fe, Cu and W are investigated after they have been infiltrated as nanoparticles into STN94/YSZ symmetrical cells. The electrochemical activity of the nanoparticles are analyzed using electrochemical impedance spectroscopy (EIS) at open circuit voltage (OCV) under different gas atmospheres and temperatures. EIS data are correlated directly with *operando* Raman spectroscopy measurements that report on the real-time material composition of the STN infiltrated electrodes under polarization. Additional analysis by scanning electron microscopy on samples before and after testing showed how electrode structure devolved during the tests. The combination of *operando* Raman spectroscopy and EIS analysis was used to correlate changes in the impedance response to changes in the surface chemistry as in FIG.1 and to clarify differences in coking behavior between the nickel and cobalt infiltrated STN.

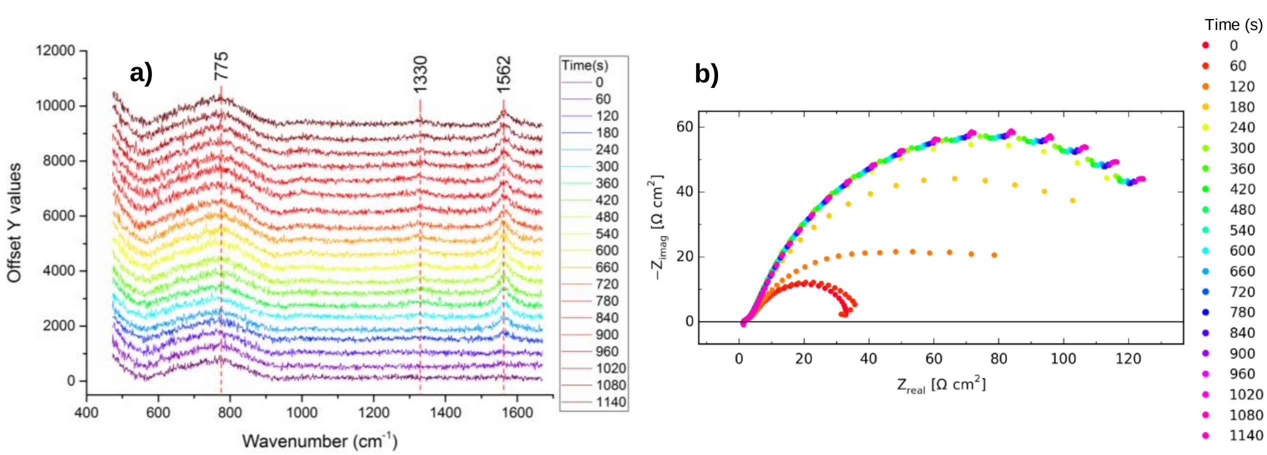

FIG.1. The response of a nickel infiltrated STN symmetrical cell to changing the atmosphere from 3% H_2O/H_2 to pure CH_4 a) The Raman signal and b) the impedance respond.