MICROSTRUCTURAL AND ELECTRO-CHEMICAL CHARACTERISATION OF LSFC-BASED CATHODES FOR ANODE-SUPPORTED SOLID OXIDE FUEL CELLS

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With the aim to improve the long-term reliability of SOFC stacks, it would be desirable to reduce the operating temperatures to 750 °C or below. This requires the use of new cathode materials compared to state-of-the-art cathodes based ((La,Sr)MnO_3 (LSM)) lanthanum strontium manganites. Promising candidates replacing the LSM-based cathodes are mixed-conducting cobaltites or ferrites.

Anode-supported single cells, investigated in this study, consist of a cathode of a $La_{0.58}Sr_{0.4}Fe_{0.8}Co_{0.2}O_{3-\delta}$ (LSFC) perovskite, a $Ce_{0.8}Gd_{0.2}O_{2-\delta}$ (CGO) interlayer (see e.g. Fig. 1), together with a 10 µm thick 8YSZ electrolyte, an anode functional layer and a 1.5 mm thick anode substrate of nickel/8YSZ cermet.

The presence of the CGO interlayer between cathode and electrolyte is needed to prevent the formation of $SrZrO_3$ near the cathode/electrolyte interface. This oxide finally led to failure of the SOFC.

In particular, attention was paid to the influence of sintering temperature of the CGO interlayer with respect to the microstructure and the electrochemical performance, i.e. current density and area specific resistance. In addition, some preliminary experiments were performed with a different composition cathode material ($La_{0.8}Sr_{0.2}Fe_{0.8}Co_{0.2}O_{3-\delta}$). The properties of the LSFC-based single cells are compared to the $La_{0.65}Sr_{0.3}MnO_{3-\delta}$/YSZ-based single cells as reference material.

The results have clearly shown that with the given conditions, an LSFC cathode together with a CGO interlayer significantly improved the overall power densities (see Figs. 2 and 3). The best performance was obtained with sintering temperatures of at least 1300 °C for the CGO interlayer. Lower sintering temperatures resulted in lower performances, which can be attributed to insufficient adhesion between the CGO interlayer and the 8YSZ electrolyte.

Comparing preliminary results from two different LSFC cathodes, i.e. $La_{0.58}Sr_{0.4}Fe_{0.8}Co_{0.2}O_{3-\delta}$ and $La_{0.8}Sr_{0.2}Fe_{0.8}Co_{0.2}O_{3-\delta}$, it was concluded that a higher La-content (lower thermal mismatch) reduces the electrochemical performance to a level close to the reference LSM/YSZ cell.

More research is still needed to further improve the material properties and processing parameters in order to reach higher electrochemical performance at lower operation temperatures and long-term stability of LSFC-based cathodes for anode-supported single cells.

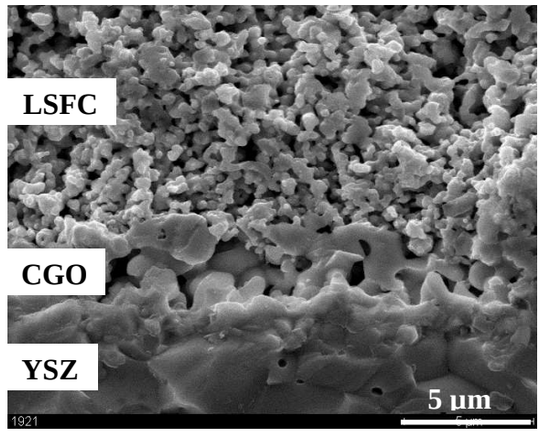

Fig. 1: Microstructure of an LSFC cathode on a CGO interlayer, sintered at 1080 °C and 1300 °C, respectively

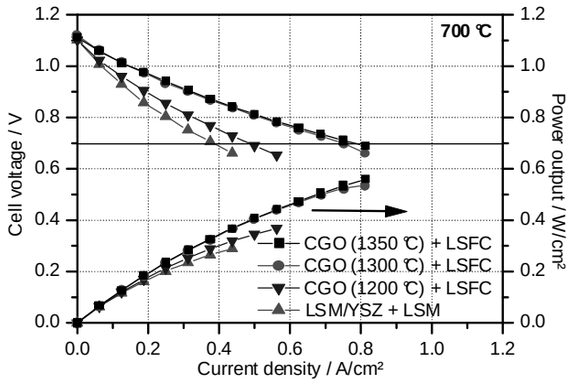

Fig. 2: Current – voltage curves at 700 °C of $La_{0.58}Sr_{0.4}Fe_{0.8}Co_{0.2}O_{3-\delta}$ -based single cells as a function of the sintering temperature of the CGO interlayer (fuel gas: H (3% H_2O) = 1000 ml/min, oxidant: air = 1000 ml/min).

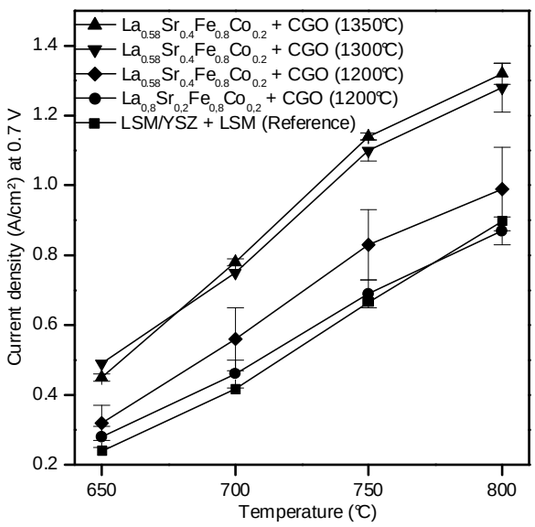

Fig. 3: Current densities at 700 mV of cells with LSFC cathodes compared to LSM cathode as a function of the sintering temperature of the CGO interlayer.