MECHANICAL CHARACTERIZATION OF Ni-YSZ FUEL ELECTRODE FOR SOLID OXIDE CELLS

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ABSTRACT

Solid Oxide Cells (SOCs) are electrochemical devices typically operated at temperatures of 750-850ºC that directly convert a fuel (typically hydrogen) into electricity (fuel cell mode, SOFC) or electricity into hydrogen (electrolysis mode, SOEC). Nowadays, the State-of-the-Art (SoA) cells consist of a ytria stabilized zirconia (YSZ) dense electrolyte, a porous fuel electrode of Ni-YSZ cermet, a porous oxygen electrode of Lanthanum Strontium Cobalt Iron (LSCF) and Gadolinium-doped Ceria (GDC) barrier layer sandwiched between the oxygen electrode and the electrolyte to limit their reactivity. In recent years, the interest on SOCs has grown significantly thanks to their wide range of technological applications that could offer innovative solutions for the transition toward a renewable energy market.

Despite of their advantages, the electrochemical and mechanical performance degradation of SOCs, especially in SOEC mode, is still relatively significant to envisage the competitive deployment of this technology. These degradation issues are caused by various aging phenomena activated at high operation temperature for long-term periods (>1000 h). Among them, the microstructural evolution of Ni within the Ni-YSZ electrode can represent a strong contribution (>30%) to the global electrochemical degradation in SoA cells. The most typical aging phenomena are the Ni agglomeration resulting in a phase coarsening, and the Ni migration changing its distribution at the fuel electrode. In addition, accidental redox cycles can cause fractures at the YSZ grain boundaries, Ni-YSZ detachment, continuous Ni agglomeration and changing porosity. They lead to a remarkable decrease in both the electrochemical and mechanical performance of cell, or an irreversible mechanical failure in the cell, especially after redox cycle. Given that there is a growing interest in understating the Ni-YSZ evolution, their microstructure and mechanical properties at the micro-scale level are explored.