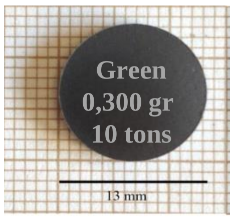
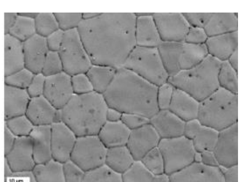
MINISTERO DELL'ISTRUZIONE DELL'UNIVERSITA' E DELLA RICERCA

PRIN 2010-2011 “BIOITSOFC”
Intermediate temperature solid oxide fuel cells fed by bio-fuels (BIOITSOFC)





The main goal of the project is to explore innovative materials and new processes suitable to run Solid Oxide Fuel Cells fed by biofuels at intermediate temperature (500--700°C) for the distributed generation of electrical energy. The research will then focus on optimizing the compositions and microstructure of electrodes and the electrolyte using appropriate deposition techniques such as electrophoretic deposition, spray coating and screen printing. The electrochemical and physico-chemical characterizations of components and cells will be addressed to individuate relationships between the nanostructure of the materials and their performance/activity with respect to both anode and cathode processes. Moreover, a structural characterization of electrolytes and electrodes by advanced synchrotron and neutron techniques will be exploited, in operating conditions of temperature and reaction environment. The architecture of anodes suitable to be used with biofuels will be designed, realizing a bi-layered anode consisting of an interlayer in contact with the fuel and a functional layer facing the electrolyte. The former will promote conversion of large molecular weight hydrocarbons and contaminants species into favourable species where the electrochemical oxidation of the converted stream will occur mainly within the functional layer. Thus, the interlayer will be composed of materials that do not degrade in the presence of sulphur. Half-cells with different architectures and compositions will be produced. The half-cells will be properly sintered and the final device will be characterized in term of macro- and micro-structure, porosity, interfaces between layers. The characterization performed in situ or ex situ and the sintering behaviour analysis will be useful to validate the design procedure and simulations previously performed. This will provide information on how to modify the cell architecture in terms of layers' thickness or interlayers and optimize the processing conditions in terms of sintering cycles, sintering aids or pore formers. The best performing materials and components will be subjected to experiments in a planar short stack configuration (10 cells) as a proof-of-concept for the novel materials and processes developed in the project. The novel materials and processes will be subjected to a life cycle assessment. A mathematical model for IT-SOFCs operated with liquid fuels and bio-fuels (bio-gas, ethanol and methanol) will be developed. Aim of is to describe the catalytic, electrocatalytic and diffusive phenomena that control the observed performances. A one-dimensional, steady state, isothermal, heterogeneous, multicomponent and multireaction Membrane Electrode Assembly (MEA) model will be developed. Moreover, the definition of the architecture of a planar SOFC operating at intermediate temperature (IT-SOFC) ranging between 500 and 700°C and fed by bio-fuels (alcohols, biogas) and the determination of fuel cell operating conditions will be accomplished.