MATERIALS SCIENCE AND TECHNOLOGY

DISAT - Development of enhanced ceramic materials for optimized reversible operation of solid oxide cells

Funded By	Dipartimento DISAT
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Context of the research activity	Research and development on materials and surface engineering to achieve an improvement of all the components present on the SoA solid oxide cell stacks especially related to high performing ceramic coatings for metallic interconnects). Innovative manufacturing technologies (Rapid Thermal Annealing coupled with Electrophoresis) will ensure the high quality, high reliability and scalability of the different components, whilst improving their microstructures and features.
Objectives	EDP is a deposition method by which particles pack closely and compactly on a substrate, directly from a suspension under the effect of an electric field thereby making it possible to deposit homogeneous layers in a few seconds. Although not traditionally implemented in the SOC industrial process, it has already been validated as a cost-effective mass production process in other industrial sectors and POLITO has been the first to test the method for the manufacturing of SOC stacks operated for 3000 h at 850¿C. They have successfully demonstrated EPD as a sound and practical deposition method of ceramic coatings on an industrial scale and laid its groundwork for use in developing ceramic protective coatings for SOCs to ensure their high quality and low cost. This method increases reproducibility, reduces costs by 20% and reduces the use of critical raw materials, while improving the performance and durability of the rSOCs. An innovative approach to spinel-coated interconnects, with improved durability and functional properties in rSOC mode, is based on “in-situ” MnCu-based spinel modification routes and will be achieved through: (i) The development of thick (10-15µm) MnCu-based spinels (Fe-doped, to improve the MnCu spinel stability range) deposited by electrophoretic deposition (EPD) and the subsequent scaling-up to industrially dimensions, with homogeneous coating thickness and good surface coverage even for corrugated and channelled 441 surfaces. Aqueous and/or organic solvent-based suspensions for the EPD co-deposition of precursors and spinel powders will be optimized considering applied voltage, time and Z potential and will be tuned to obtain homogeneous coatings on 441 IC, further densified by heat treatment.

	(ii) RF Sputtering, as both an alternative (from a metallic CuMn or an oxide (Cu, Mn)3O4 sputtering target) and in combination with the EPD technique, to design and process innovative functional coatings with an intermediate nanometric Ce-based layer at the IC grain boundary, to block Cr outward diffusion in the oxide scale, between the IC and the EPD deposited spinel. The rapid thermal annealing, coupled with 3D printing techniques (robocasting and stereolithography) will be also considered, to reach the sintering temperatures in shorter times, thus limiting unwanted reactions.

Skills and competencies for the development of the activity	Ceramic sintering, electrophoretic deposition, solid oxide cell functionalities