Cathode optimization for solid oxide fuel cells: experiments and numerical modeling

Ozden CELIKBILEK

Supervisor: Elisabeth Djurado (LEPMI) and Christophe L. Martin
Co-tutors: Monica Burriel (LMGP) and David Jauffrès

Friday, December 9th at 2:00 pm

Amphitheater Jean Besson – Phelma Campus

Abstract: Understanding, controlling and optimizing the mechanism of oxygen reduction reaction at the cathode need to be addressed for high performance energy conversion devices such as solid oxide fuel cells (SOFCs). Structured porous films of mixed ionic electronic conductors (MIECs) and their composites with addition of a pure ionic conductor offer unique properties. However, correlating the intrinsic properties of electrode components and microstructural features to performance remains a challenging task. In this PhD thesis, cathode functional layers (CFL) of $La_{0.6}Sr_{0.4}Co_{0.2}Fe_{0.8}O_{3-\delta}$ (LSCF) and LSCF/$Ce_{0.9}Gd_{0.1}O_{2-\delta}$ (CGO) composite cathodes with hierarchical porosity from nano- to micro-range are fabricated by electrostatic spray deposition technique. The films were topped with LSCF as a current collecting layer (CCL) by screen printing technique. A parametric optimization study was conducted experimentally in terms of sintering temperature, composition, and thickness of CFL and CCL layers. The experimental results were supported by a numerical 3D Finite Element Model (FEM). Microstructural parameters determined by FIB-SEM tomography were used in a simple geometry similar to experimentally observed columnar features. In this work, experimental results and modelling were combined to provide design guidelines relating optimized electrochemical performances to the microstructure and bulk material properties. A complete fuel cell with optimized cathode film was tested in long term degradation in real SOFC operational conditions.