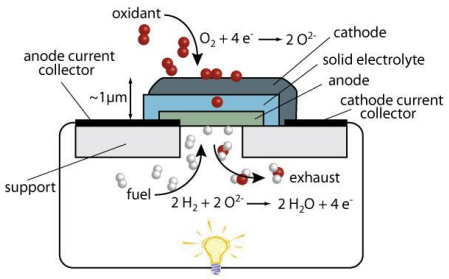
Bachelor thesis
Master project / Master thesis

Start: anytime in 2011

ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

$La_{0.6}Sr_{0.4}CoO_{3-\delta}$ cathodes for miniaturized solid oxide fuel cells

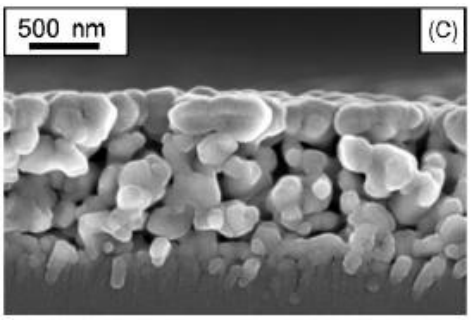
Context: Solid oxide fuel cells (SOFC) are ceramic devices that convert chemical energy directly into electrical energy. New concepts, materials and microstructures are currently sought in order to integrate miniaturized SOFC (micro-SOFC) onto silicon chips for mobile applications, such as notebooks and cell phones [1]. One current limitation of the cell performance is the electrochemical activity of the cathode towards oxygen reduction.



Working principle of a micro-SOFC

Array of 30 micro-SOFC integrated on Si wafer

Aim: In the framework of the national project OneBat [2] and in collaboration with two Korean and Swiss partners, the aim of this study is to fabricate $La_{0.6}Sr_{0.4}CoO_{3-\delta}$ (LSC) cathodes exhibiting high electrochemical activity. The electrode will be prepared by spray pyrolysis based on the work of Beckel [3]. An area specific resistance lower than 0.5 ohm.cm^2 at 550°C is targeted for oxygen reduction to obtain acceptable cell power density. Notably the influence of the microstructure and thickness of the films on the electrochemical performance will be investigated. The results are aimed to be published in peer-review scientific journals.



Cross-section micrograph of a LSC electrode deposited by spray pyrolysis [3]

Approach: The LSC films will be fabricated with spray pyrolysis on Ce-Gd oxide electrolytes. The microstructure of the LSC films will be investigated qualitatively (by SEM) and quantitatively (by continuous phase size distribution [4] and FIB-nanotomography). The electrochemical performance will be evaluated by steady-state voltammetry and impedance spectroscopy between 400°C and 600°C in air as a function of the LSC thickness (50-1000 nm) and crystallinity. The LSC cathodes will be then integrated on anode-supported SOFC and free-standing Si-based micro-SOFC.

Main techniques used: spray pyrolysis, SEM, FIB, XRD, continuous phase size distribution, impedance spectroscopy, voltammetry, microfabrication.

Requirements: Education in materials science, chemistry, physics or related fields. Good command of spoken and written English. Interest in working in a multidisciplinary and international environment.

[1] A. Evans *et al.*, J. Power Sources, 194 (2009) 119

[2] http://www.nonmet.mat.ethz.ch/research/onebat

[3] Beckel *et al.*, Solid State Ionics.,178 (2007) 407

[4] B. Münch *et al.*, J. Am. Ceram. Soc, 91 (2008) 4059

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