2023-2024 Internship proposal at LMGP Lab.

In situ Raman studies on oxygen electrode materials for solid oxide cells (SOCs)

Context

The EU goal of cutting greenhouse gas to zero net emissions by 2050 will put particular pressure on energy conversion and storage systems. Reversible Solid Oxide Cells (rSOCs) are capable of efficiently operating in two modes: (1) as solid oxide fuel cell (SOFC), where chemical energy, e.g hydrogen gas is converted into electricity with water as the only by-product; and (2) as solid oxide electrolyser cell (SOEC), where electrical energy can be transformed into chemical energy in hydrogen gas via the electrolysis of water. The electrolyser mode is also known as the Power-to-Gas (P2G) solution for long-term and up-scaling Electrical Energy Storage (EES). Of particular interest are thin film rSOCs (or µ-SOCs) that require minimal amounts of critical raw materials (CRMs) to achieve pocket-sized kW range stacks by exploiting nanoscale transport phenomena. To operate the cells with high efficiency and long duration, material selection and development plays a pivotal role in the performance and commercialisation of thin film SOCs.

Among all the components, oxygen electrode is one of the essential components. High efficiency of the oxygen reduction reaction (ORR) and oxygen evolution reaction (OER), fast electronic and ionic conductivity, as well as good stability, are desirable prerequisites for any potential oxygen electrode material. The goal of this project is to explore the thin film deposition conditions and to perform structural characterisation as well as advanced characterisation on the mass transport in the materials in order to identify pathways for better performance of oxygen electrode for SOCs.

Project description

In this project an in-house designed *in situ* Isotopic Exchange Raman Spectroscopy (IERS) technique [1] will be widely applied to investigate the oxygen surface exchange and diffusion behaviour within the thin film materials. Advanced Raman mapping methods will also be applied to obtain spectral information from different regions of the samples.

The Master student will be involved in the growth, structural and/or performance characterisation of the thin films as well as in data processing, report writing and group meeting presentation. The thin films will be firstly deposited by Metal Organic Chemical Vapour Deposition (MOCVD) and characterised by X-ray diffraction (XRD), secondary electron microscopy (SEM) and atomic force microscopy (AFM). The mass transport in the materials will be further studied with impedance spectroscopy and, especially, IERS at elevated temperatures and various oxygen partial pressures. The measurements will provide insights in the structural, and mass transport behaviour of the deposited thin film materials with the potential application in SOCs.

Scientific environment

The candidate will work within the LMGP, Materials and Physical Engineering Laboratory, in the Oxides in *Nanoionic* Device group (https://lmgp.grenoble-inp.fr/en/research/oxides-for-nanoionic-devices) within the *Nanomat* team.
Located in the heart of an exceptional scientific environment, the LMGP offers the applicant a rewarding place to work.
LMGP Web Site: http://www.lmgp.grenoble-inp.fr/

Profile & requested skills

We are looking for a highly-motivated Engineering School or M2 Masters student with a strong interest in experimental chemical physics and materials science, especially in energy technologies, electrochemistry, and defect chemistry. Interpersonal skills, dynamism, rigor and teamwork abilities will be appreciated. Candidates should have good writing and speaking skills in English. Group meetings and supervision will be in English.

Contact :

To apply, please send a CV and motivation letter to:

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Mónica Burriel (Co-supervisor) monica.burriel@grenoble-inp.fr

Should you require any further details on this project, please contract Zonghao Shen and Mónica Burriel.

References :

[1] A. Stangl *et al., Adv. Mater.*, 35 (33) 2023, 2303259