LMGP

PHD THESIS OFFER 2024-2027

Functional thin films for high-performance Solid Oxide Cells (SOCs)

Doctoral school / Starting date

IMEP2 / Starting date: 01/10/2024

Subject

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. Despite their potential to revolutionize the storage sector, SOCs come with several drawbacks due to their high operating temperatures. Additionally, the current state-of-the-art SOCs rely on significant amounts of CRMs or materials with high supply risks, such as rare-earth elements or cobalt, which hinder their widespread deployment. To overcome these limitations, it is crucial to improve rSOCs by reducing their size while also minimizing the CRMs content. This can only be achieved through ground-breaking progress in materials and innovative architectures that enable high energy density, exceptional thermomechanical response, and outstanding performance and durability at lower costs.

THESIS PROJECT

To achieve the highly ambitious performance goals for solid oxide fuel cells and electrolyzers at intermediate operating temperatures, this **thesis proposes the design, optimization, and characterization of new electrode and electrolyte compositions and microstructures**.

To accomplish this, we suggest employing new thin film compositions using two specific techniques: Metal Organic Chemical Vapour Deposition (MOCVD) and atomic layer deposition (ALD), either individually or in combination. In addition to standard structural, chemical, morphological, and electrochemical characterization, we will utilize new advanced in situ characterization techniques combined with an original electrochemical pumping methodology to establish links between structure/microstructure/composition and the functionality and performance of these thin film oxide materials.

RESEARCH ACTIVITIES

Within this very exciting project, the PhD student will:

- focus on the investigation of oxide thin films for solid oxide cell (SOC) devices, such as solid oxide fuel cells and electrolysers

For this the PhD student will mainly in charge of the:

- Deposition and tuning of electrolyte and electrode materials by MOCVD and/or ALD
- Electrochemical characterization of thin film electrolytes and electrodes (10-100 nm) in engineered stacks for improved performance
- Development and implementation of advanced *in situ* and *operando* characterization techniques for Nanoionics

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Scientific Environment

The PhD student will be based at **LMGP, Materials and Physical Engineering Laboratory** and will work within the NanoMat team, and specifically in the **Nanonioncs group**, led by Dr Burriel. 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

Required

- Master Degree (or equivalent) in physics, chemistry, chemical engineering or materials science, preferably with a Master's thesis project related to thin films
- Knowledge in materials science, especially in Solid State Ionics and Electrochemistry
- Fast learner, hands on and flexible attitude
- High degree of responsibility and independence, while collaborating with your team and lab mates, and other laboratory staff.
- Good management skills, good presentation skills, excellent written and oral English level (among non-native English speakers, equivalent TOEFL score of 100 or higher).
- Be someone able to and enjoy to solve problems and pushing your research to achieve results

Highly desirable

- Experience in thin film deposition techniques (CVD, MOCVD, ALD, SALD, MBE)
- Experience in processing, developing and characterizing thin films via techniques such as XPS, XRR, XRD, TEM, SEM, SIMS, AFM, ellipsometry, electrical and electrochemical characterization
- Programming skills (labview/python/matlab/etc)
- Experience in building and/or setting up laboratory equipment or simple systems

Salary

2100 € gross/month

Supervisor

Dr Mónica BURRIEL (LMGP): monica.burriel@grenoble-inp.fr

Application procedure

For further information don't hesitate to contact us.

To apply please send by email **ASAP** and before **the 10th May 2024** your:

- Detailed Curriculum Vitae
- Cover letter explaining the motivation for the PhD work
- Transcript of marks obtained in Masters
- Contact details of two referees