PhD position

Thesis subject: **Optimization of the cathode microstructure for high-temperature CO_2 electrolysis**

Laboratory of assignment: Laboratory of Electrochemistry and Physical-Chemistry of Materials and Interfaces

Context and work environment

Structure description

The LEPMI (UMR 5279) is a joint research unit involving Grenoble-INP, Grenoble Alpes University, CNRS and Savoie Mont-Blanc University. The laboratory brings together expertise in most areas of electrochemistry, particularly in electrochemical energy production and storage and photovoltaics, by combining materials science and electrochemical engineering.

Team description MIEL (Material Interfaces Electrochemistry): under the authority of Dr Cristina Iojoiu. Team is composed of 58 agents (19 researchers, 28 PhD students, 2 technical staff, and 9 collaborative researchers)

The activities of the MIEL team encompass electrochemistry and materials science and mainly deal with electrochemical conversion and storage of energy of low (battery, PEMFC) and high (SOFC, SOEC) temperature devices. The cement of our activities as well as the use of electrochemical methodologies and common descriptors, focus on the electrolyte, the electrodes and their interfaces.

A team's strength is to combine the conception and manufacturing of the functional materials, their in-depth characterizations (physical-chemistry, electrochemistry), and their integration into electrochemical devices related to the targeted application.

The team activities are decomposed into 4 scientific axes that illustrate our expertise (synthesis, elaboration, characterization, electrochemistry) which are fed by numerous international and national collaborations. In addition, the experimental activities are exploiting a wide range of specific devices and different platforms such as the Battery, Raman, and M2E, all managed by the MIEL team for the LEPMI laboratory.

Position's mission and main activities

Context:

The electrochemical conversion of CO_2 into fuels or low-carbon chemicals using clean electricity has been recognized as an effective and sustainable way to reduce our carbon footprint and control global warming. Among the various CO_2 conversion technologies, solid oxide electrolysis cells (SOEC) have been identified as one of the most promising devices for the direct electrolysis of CO_2 to CO with high efficiency. The most critical component in a SOEC is the cathode, where the electroreduction of CO_2 takes place. Cathode materials must have a porous microstructure (path for gas diffusion), high electronic conductivity (to provide electrons for the CO_2 reduction reaction), ionic conductivity (to transport oxygen

ions from the cathode to the electrolyte), excellent catalytic activity for CO_2 reduction and prevention of carbon formation.
The development of cathode materials and architectures with high electrocatalytic activity and long-term stability for CO_2 electroreduction at high temperatures (800°C) remains a challenge for SOECs.

Mission:
The objective of this thesis is to correlate the electrochemical performance of a SOEC with the optimization of the cathode microstructure and architecture (thickness, porosity, tortuosity...) in order to improve the gas phase transport. The reaction mechanisms, stability, redox properties, and aging of the cathode materials will be studied by electrochemical methods (electrochemical impedance spectroscopy, cyclic voltammetry) coupled with structural (X-Ray Diffraction and in situ and in operando IR and Raman spectroscopies) and morphological (Scanning Electron Microscopy) characterization methods.

Main activities:
The activities listed are of equal importance and proportion
Synthesis and optimization of materials
Electrochemical characterizations
Structural and morphological characterizations

Expected profile

Expected skills (priority) :

- ***Trade skills/ expertise***

Technical and scientific skills in materials science and characterization
Write a report
Present results in a clear and pedagogical way and adapted to the audience
Have a B2 level in English

- ***Personal skills***

Demonstrate critical thinking skills
Ability to work in a team
Ability to take initiative

Desired professional experience: ☒ beginner ☐ 2 to 5 years

Previous formation, diplomas:
The candidate should have a Master's degree, or an engineering degree, with, if possible, a background in physical chemistry and/or solid chemistry. A particular interest in electrochemistry will be appreciated.

General information

Contact for the questions related to the position:

Cécile Rossignol (Associate professor UGA): Cecile.Rossignol@grenoble-inp.fr
Nicolas Sergent (Associate professor Grenoble-INP): Nicolas.Sergent@grenoble-inp.fr

Applications must be sent before May 5, 2023. It is strongly recommended to contact the supervisors as soon as possible to indicate your interest in the subject. All applications must include the following elements
- Motivation letter
- CV

- Copy of diplomas
- Transcripts of grades

An audition of the shortlisted candidates will take place at the end of May.

Thesis start date: between October 1st, 2023 and November, 1st 2023

Supervisors: Cécile Rossignol and Nicolas Sergent

Funding: CDP DefiCO2 and LabEx CEMAM

Keywords: High-temperature CO_2 electrolysis - Microstructure