Demande de Publicité Internationale
Recrutements prévus dans les Projets ISITE-BFC
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Job title	**Behavior and durability of protonic ceramic electrochemical cell (PCEC) integrated in a stack.**
Ref	Complété par UBFC
Date de mise en ligne souhaitée	**March 15th, 2021**
Job type (PhD, Post-doc, Engineer)	**PhD**
Contract duration (months)	36 months
Qualifications (Master degree, PhD…)	Master degree
Job hours (full time/ part time)	Full time
Employer	UBFC – Université de Franche-Comté
Host Laboratory	Laboratoire ICB – UMR 6303 CNRS – Université de Bourgogne Franche-Comté Institut Femto-ST – UMR 6174 CNRS – Université de Bourgogne Franche-Comté
URL Host Laboratory	http://icb.u-bourgogne.fr and https://www.femto-st.fr/fr
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Job description	**Context:** To ensure the energy transition, the use of hydrogen as energy vector appears to be an unmissable solution. Production of green hydrogen by the use of electrolysis process prevent formation of CO_2 gases. In this context, solid oxide electrolyser, which presents high efficiency, is considered as promising production methods [1]. **Territorial anchorage:** The Burgundy Franche-Comté region is labeled «Hydrogen Territory» since 2017 by introducing the ENRgHy project whose objectives are to develop advances on the storage and production of energy by hydrogen. In this context, the ICB and Femto-St laboratories are partners of the FCLAB (Fuel Cell Lab), which brings together all the academic and industrial actors of the North East of France. The Hydrogen 2020 investment plan, announced by the government, reinforces these research topics in which our laboratories has been involved since 1994. **State of the art:** Research on fuel and electrolyser cells has so far focused on two axes: low temperatures ($25 < T < 180°C$) dominated by polymer electrolyte membrane and high temperatures, ($500 < T < 1000°C$) for SOFC (Solid Oxide Fuel Cell) and SOEC (Solid Oxide Electrolyser Cells). Since the 2000s, there has been a

	growing interest in PCFC proton-conduction ceramic fuel cells, a system that combines the benefits of PEMFCs and SOFCs. The operation of the PCFC is based on proton conduction of a ceramic electrolyte in the 400 – 600°C temperature range. In this temperature range, the ageing of materials is less important than in the case of SOFC due to a lower temperature range. The use of PCFC in reversible mode permits hydrogen production by using water and current. These systems are called PCEC (Protonic Ceramic Electrochemical Cell) [2]. The compounds AMO_3 based type (A = Ba, Sr; M = Ce, Zr, perovskite structure) are the most studied materials at present in the field of PCFC electrolytes. In these compounds, the substitution of the metal cation M by a trivalent cation (Y, Gd, In, Sc, etc.) enables the diffusion properties of hydrogen to be exalted within the crystalline network of the material. To date, $BaCe_{0.9}Y_{0.1}O_{3-\delta}$ (BCY10) has one of the strongest proton conductivities at 600°C among perovskite structural oxides but shows low stability under hydrogen. Substitution with Zr increase the chemical stability with no significant protonic conductivity decreasing [3]. **Description of the thesis:** The works carried out during this PhD will be based on the ICB's achievements in the fabrication of cells for PCFC and PCEC applications and electrochemical tests management. Three main areas will be addressed. The first will involve the shaping of large (diameter 5 cm) and button cells (22 mm diameter) for PCEC. This step, essential for the following, will be carried out by successive band casting of the different layers (electrodes and electrolyte) and will be based on the WO 2014057218 A2 patent [4]. Multi-stage sintering will be realised due to the high temperatures required to densify protonic conductors. Deposition of these electrolytes by reactive magnetron sputtering on an anodic medium may also be considered [5]. The second part will focus on the realization of electrochemical characterization using the Fiaxell test bench Technologies acquired recently by our team. The results obtained in this section will allow to understand the mechanisms during the operation of a electrolysis cell and will specify the key steps that lead to the performance of PCFCs. Finally, the third part will focus on integration of larger cells to produce a two cells stack. By testing it in real conditions, information on the compatibility, the stability and the durability of the materials core components of PCEC will be highlighted. **International collaborations:** Strong collaborations exist with the University of Genova (Italy), the Colorado Fuel Cell Center of Golden (USA) and the DLR Stuttgart (Germany), stays in these laboratories within the framework of this research will be set up for the PhD student via the mobility program of the EIPHI graduate school. [1] Acar, C., & Dincer, I. **2018**. 3.1 Hydrogen Production. Chapter in Comprehensive Energy Systems, 1–40. doi:10.1016/b978-0-12-809597-3.00304-7 [2] Ding, H., Wu, W., Jiang, C. *et al.* Self-sustainable protonic ceramic electrochemical cells using a triple conducting electrode for hydrogen and power production. *Nat Commun* **11,** 1907, **2020**. https://doi.org/10.1038/s41467-020-15677-z [3] Ricote S., Bonanos N., Marco de Lucas M-C., Caboche G., Structural and conductivity study of the proton conductor $BaCe_{(0.9-x)}Zr_xY_{0.1}O_{(3-delta)}$ at intermediate temperatures J. Power Sources - n° 193 - **2009** – 189-193 [4] V. Sivasankaran, L. Combemale, G. Caboche, Patent: Method for preparing a fuel cell WO 2014057218, https://patents.google.com/patent/WO2014057218A2/en [5] M. Arab Pour Yazdi, P. Briois, A. Billard, Influence of the annealing conditions on the structure of $BaCe_{1-x}Y_xO_{3-\alpha}$ coatings elaborated by DC magnetron sputtering at room temperature, Materials Chemistry and Physics 117, **2009** 178–182 **Location:** the work will start at ICB in Dijon for the first months and will continue between the 2 laboratories: Femto-St in Montbéliard and ICB in Dijon in a period of 6 months typically.
Supervisor(s)	Pr. CABOCHE Gilles – gilles.caboche@u-bourgogne.fr Dr. BRIOIS Pascal – pascal.briois@utbm.fr Dr. COMBEMALE Lionel – lionel.combemale@u-bourgogne.fr

Candidate profile	Master in Materials chemistry, knowledge in ceramic elaboration, shaping and in electrochemistry – Electrochemical Impedance Spectroscopy knowledge will be very appreciated.
Keywords	Hydrogen production ; electrolysis ; protonic conduction ; stack ; electrochemical performance
Application deadline	June 1st , 2021
Starting Job	October 1st, 2021
Application *Depending on the type of position*	**PhD Position** Please send the following documents (all in one PDF file) by e-mail to "indicate contact email" : 1) For EU candidates: Copy of your national ID card or of your passport page where your photo is printed. For non-EU candidates: Copy of your passport page where your photo is printed. 2) Curriculum Vitae (1 page). 3) Letter of motivation relatively to the position (1 page). 4) Copy of your Master degree and/or Engineer degree if already available. 5) Copy of your final marks and ranks. 6) Coordinates of reference persons (maximum 3, at least your master thesis supervisor): Title, Name, organization, e-mail. If you have questions regarding the application, please contact the supervisors.