PhD fellowship offer: Coupling of a microbial fuel cell with a redox flow battery for water treatment

Location : Rennes Institute of Chemical Sciences, Campus de Beaulieu, Bâtiment 10 C, 263 Avenue du Général Leclerc 35042 Rennes Cedex, France
Doctoral school : Matière, Molécules et Matériaux (S3M)
Specialities : Physical chemistry and Electrochemistry, Analytical Chemistry, Environmental and Engineering Chemistry
Funding : Contrat doctoral ordinaire (CDO) of the University of Rennes (2 044 €/month gross salary, revised each year)
Keywords : energy, depollution, storage, organic/organometallic redox compounds, (bio)electrochemistry, flow

Project description:
The use of microbial fuel cell is an interesting approach for water treatment. The chemical energy recovered during the depollution process is transformed into electricity and can even lead to the synthesis of value-added compounds. However, these cells present low potential differences leading to relatively low power and a difficult scale up limiting their application at the industrial level.[1] Recently, it has been proposed to couple microbial fuel cells to redox flow batteries to store the electrochemical energy and to efficiently convert it into electricity.[2] Among the various emerging technologies, aqueous organic redox flow batteries (AORFB)[3] are particularly interesting because the control of the potentials of the redox compounds allowing the coupling with the microbial fuel cell is possible by molecular engineering, organometallic chemistry or coordination chemistry. Moreover, they are particularly promising to achieve the objectives in terms of sustainability, cost and safety.
This project is part of the development of a pollution control system coupling the advantages in terms of selectivity and environmental compatibility of the microbial fuel cell with a storage system, aqueous organic redox flow batteries, which can deliver high power. The work will consist in the identification/synthesis of the aqueous soluble redox compounds of the AORFB that can allow the coupling with the bioanode and the microbial biocathode of the biofuel cell, for both negolyte and posolyte. In parallel, suitable bioanodes and microbial biocathodes will be developed. Finally, the performances of the microbial redox flow cell will be evaluated in terms of energy, power density and stability.

Profile : Master 2 or equivalent with a background in (bio)electrochemistry and/or organic/organometallic chemistry. Knowledge in microbial biology will be appreciated.

Application: Candidates should send a CV and a motivation letter to:
Frédéric Barrière (frederic.barriere@univ-rennes1.fr)
Florence Geneste (florence.geneste@univ-rennes1.fr)

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[1] Kumar, A.; Hsu, Leo H.-H.; Kavanagh, P.; Barriere, F.; Lens, P. N. L.; Lapinsonniere, L.; Lienhard V, J. H.; Schroder, U.; Jiang, X.; Leech, D. Nature Reviews Chemistry (2017), 1(3), 0024.
[2] a) Santos, M. S. S.; Peixoto, L.; Azevedo, J.; Monteiro, R. A. R. ; Dias-Ferreira, C.; Alves, M. M.; Mendes, A. Journal of Power Sources (2020), 445, 227307 b) Santos, M. S. S.; Peixoto, L.; Mushtaq, K.; Dias-Ferreira, C.; Alves, M. M.; Mendes, A.; Alves, M. M. Journal of Energy Storage 39 (2021) 102610.
[3] Fontmorin, J.-M.; Guiheneuf, S.; Godet-Bar, T.; Floner, D.; Geneste, F. Current Opinion in Colloid & Interface Science (2022), 61, 101624.