DTU Library

# Graphene-Sulfite Oxidase Bioanodes for Enzymatic Biofuel Cells

**Tang, Jing; Werchmeister, Rebecka Maria Larsen; Huang, Wei; Wollenberger, Ulla; Zhang, Jingdong**

*Publication date:*
2019

*Document Version*
Publisher's PDF, also known as Version of record

DTU Chemistry
Department of Chemistry

DTU Chemistry
NanoChemistry

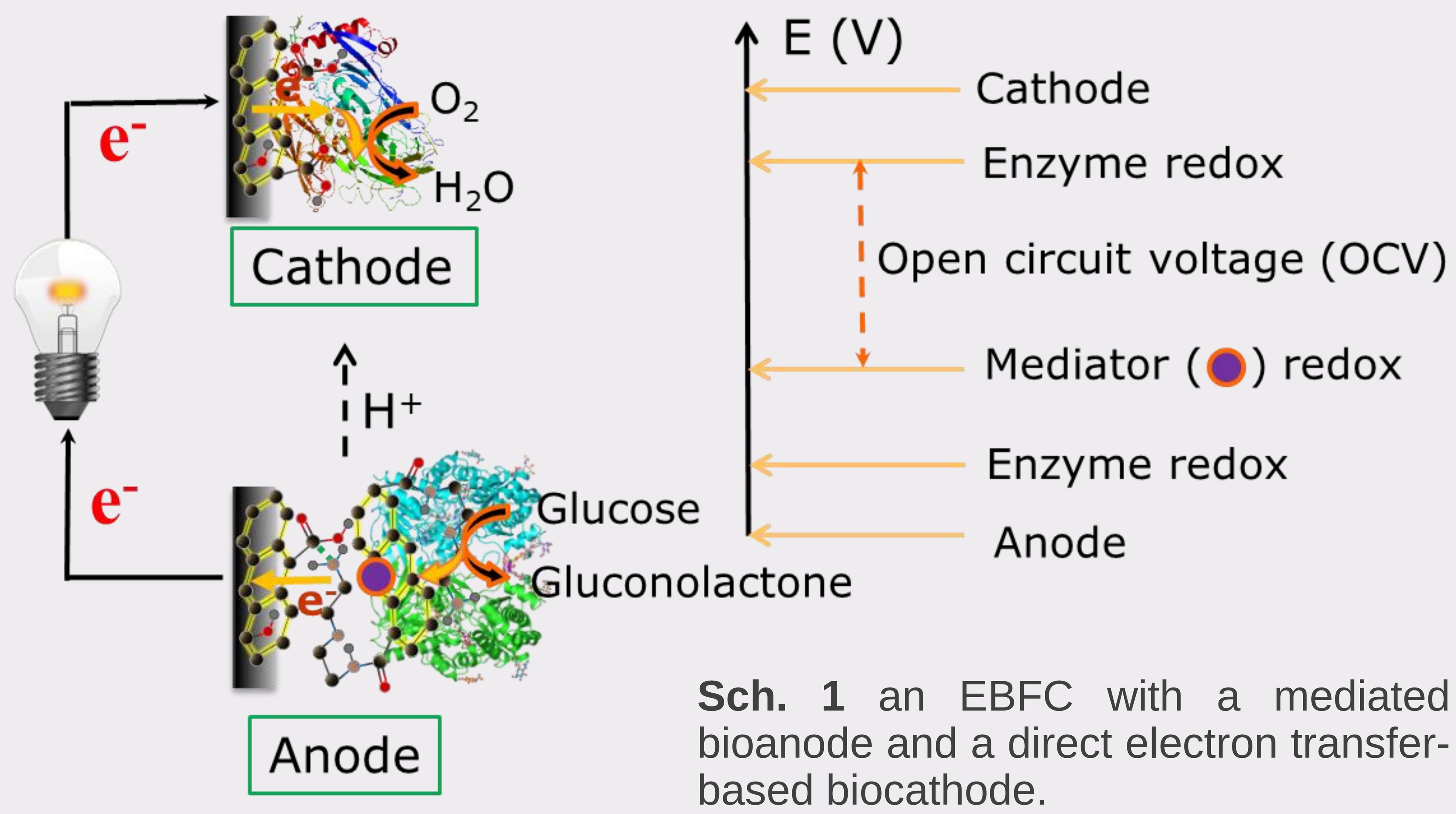
# Graphene-sulfite oxidase bioanodes for enzymatic biofuel cells


**J. Tang[1], R. M. L. Werchmeister[1], U. Wollenberger[2], C. Engelbrekt[1], J. Zhang[1]***

[1] Technical University of Denmark, Department of Chemistry, Kemitorvet 207, 2800 Kgs. Lyngby, Denmark, jz@kemi.dtu.dk
[2] University of Potsdam, Institute of Biochemistry and Biology, Karl-Liebknecht Strasse 24-25, 14476 Golm, Germany


## Introduction

Enzymatic biofuel cells (EBFCs), using enzymes as catalysts on the anode or/and cathode, offer a wide range of abundant biological fuels such as starch, glucose, fructose and lactate, etc.




**Sch. 1** an EBFC with a mediated bioanode and a direct electron transfer-based biocathode.

Although most EBFCs use organic and biological molecules as fuels, inorganics can also be utilized for EBFCs with suitable enzymes.

Anode: $SO_3^{2-} + H_2O \rightarrow SO_4^{2-} + 2H^+ + 2e^-$

Cathode: $\frac{1}{2}O_2 + 2H^+ + 2e^- \rightarrow H_2O$

Sulfite oxidases (SO) catalyze the oxidation of $SO_3^{2-}$ to $SO_4^{2-}$. Thus, they can be employed to fabricate sulfite/$O_2$ EBFCs using sulfite as the energy source.

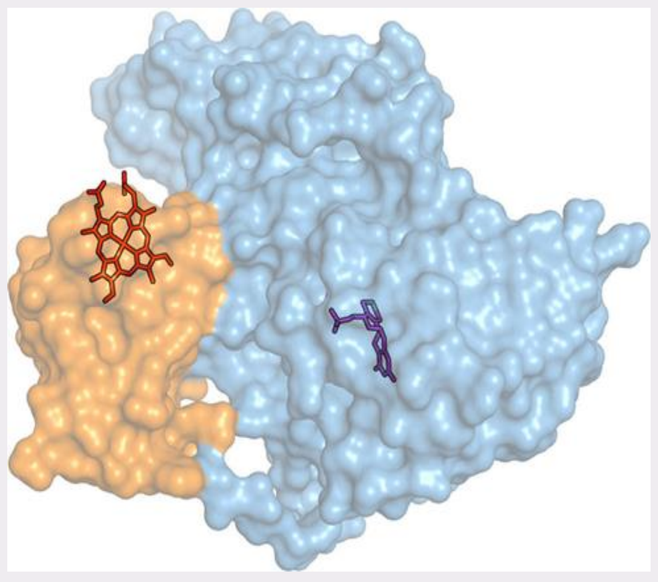
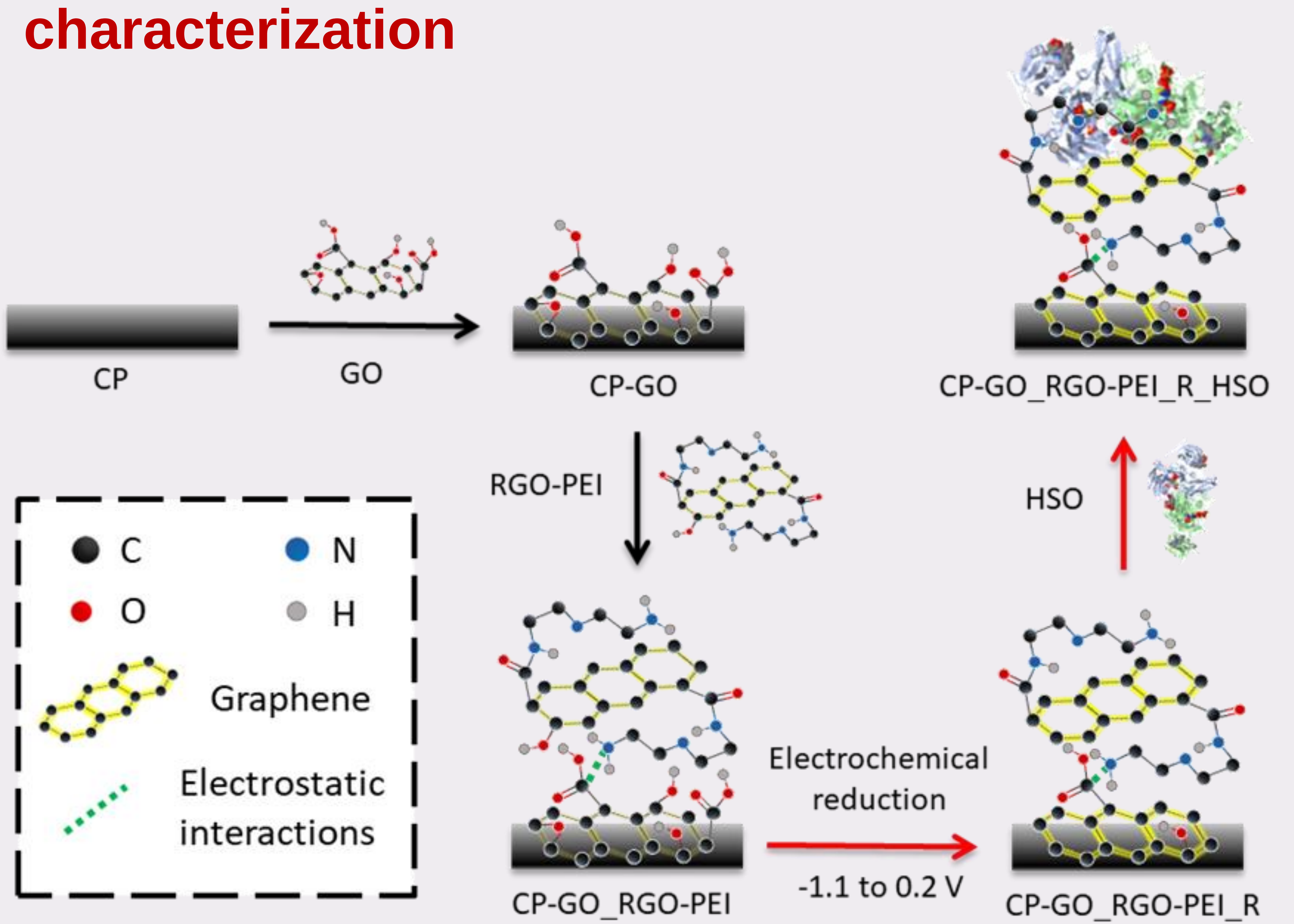


**Fig. 1** Structure of the sulfite oxidase, with the mobile heme domain in orange, and the metallic cofactors (molybdenum active site and heme) shown as sticks. *J. Am. Chem. Soc.* **2017**, 139, 11559−11567.

## Preparation of bioanodes and electrochemical characterization




**Sch. 2** Fabrication of a CP-GO_RGO-PEI_R_HSO bioanode. CP: carbon paper; GO: graphene oxide; RGO: reduced graphene oxide; PEI: polyethylenimine; HSO: human sulfite oxidase.

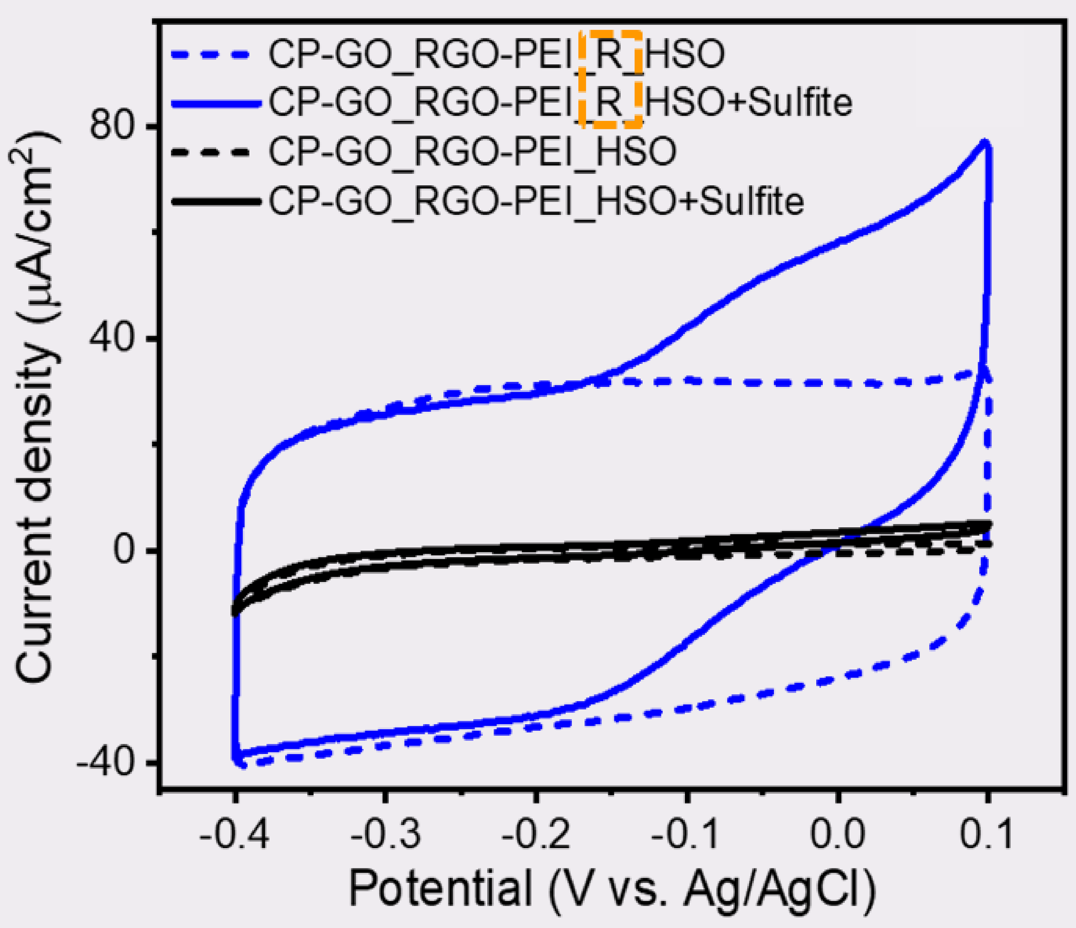



**Fig. 2** Cyclic voltammetry of the bioanode in the absence (dash) and presence (solid) of sulfite in 750 mM Tris-acetate buffer, pH 8.4, 5 mV s$^{-1}$.

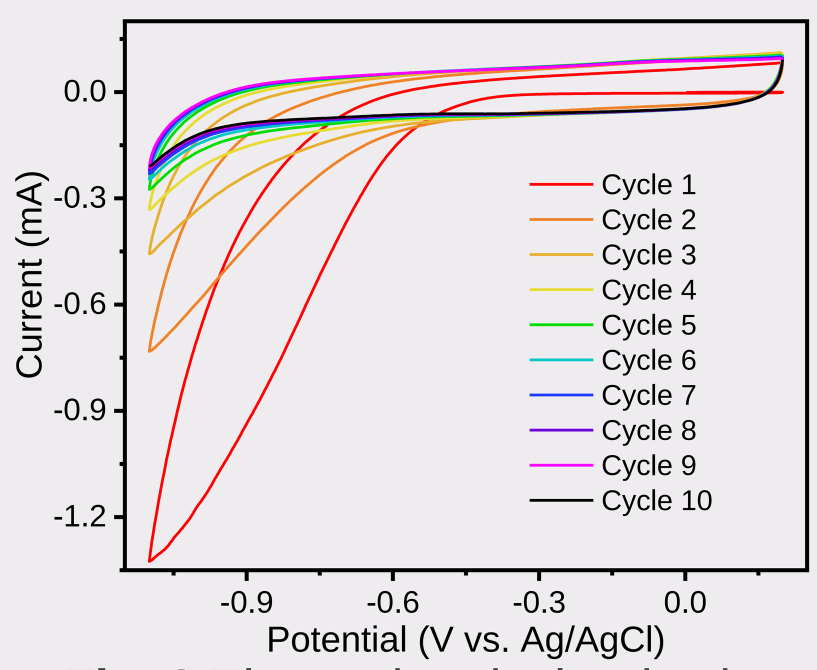



**Fig. 3** Electrochemical reduction.

The reduced bioanode exhibits both **10-fold** catalytic and capacitive current of the non-reduced one, **Fig. 2**. The promoted catalytic and electrochemical properties after reducing GO on electrodes, are due to the increased conductivity of RGO compared to GO, and the electric contact points between electrode surface and SO.

## Evaluation of sulfite/$O_2$ EBFCs

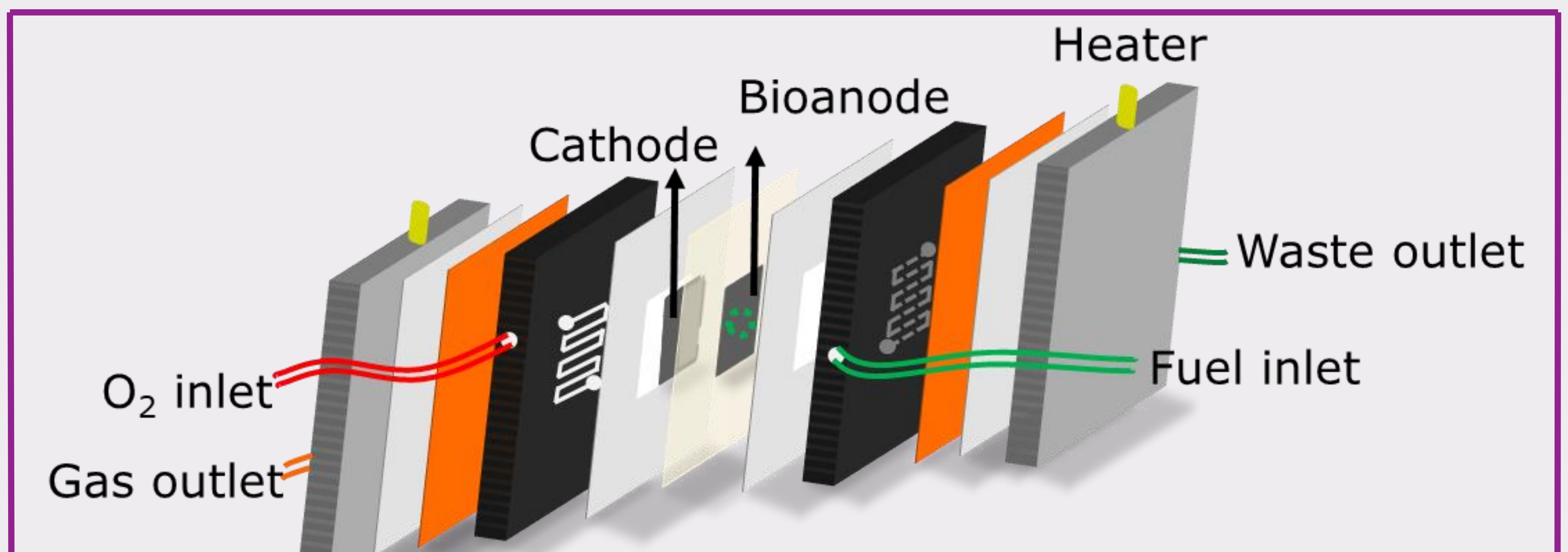
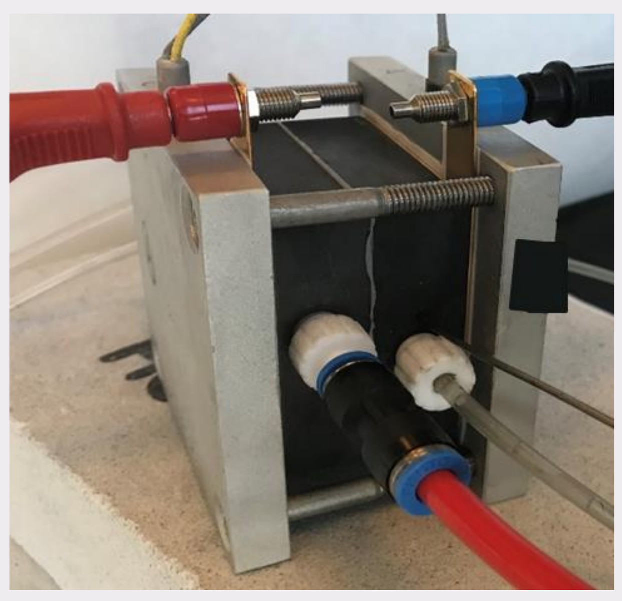



**Fig. 4** Digital photo and scheme of assembled EBFCs.



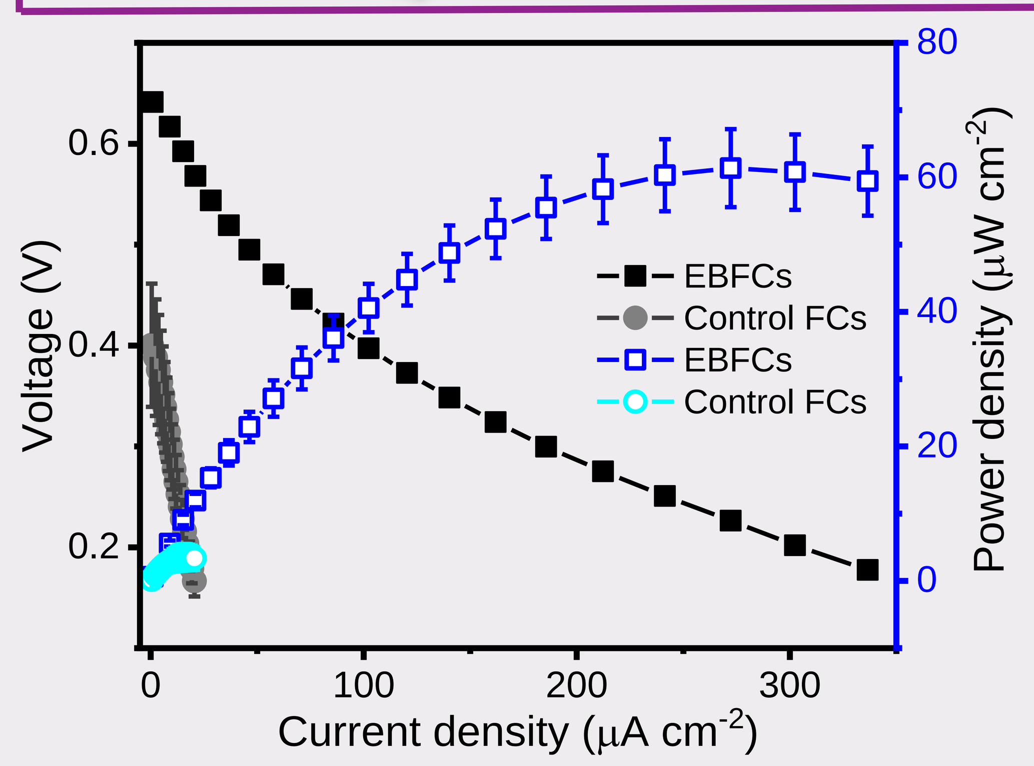



**Fig. 5** Polarization and power density curves of EBFCs and control FCs with CP-GO_RGO-PEI_R as the anode at 30 °C.

The EBFCs with an OCV of **0.64 ± 0.01 V** reach a maximum power density ($P_{max}$, **61 ± 6 μW cm$^{-2}$**), while control FCs show an OCV of 0.40 ± 0.06 V and a $P_{max}$ of 4 ± 2 μW cm$^{-2}$. It indicates that the sulfite/$O_2$ EBFCs works.

## Perspectives

Fabrication a biocathode for EBFCs will be the next step.

## Acknowledgments


Financial support from Danish Council for Independent Research Technology and Production Sciences (DFF –YDUN 4093-00297) is greatly acknowledged.