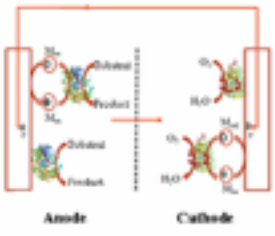
Labex MATISSE

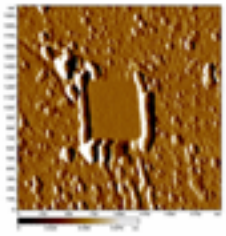
Axis 3 INTERFACES, TRANSPORT, REACTIVITY IN NATURAL MEDIA

« Development of a new generation of electrodes for biofuel cells by direct electron transfer»

Achraf Blout

Hosting laboratories: Laboratoire de Réactivité de Surface et Laboratoire Interfaces et Systèmes Electrochimiques





On the left: Schema of a biofuel cell principle

On the right: Amplitude AFM image in tapping mode of an electrode Si/a-CNx/oxidize laccase after scrapping in contact mode

Hosting laboratories, teams andand thesis supervisors names:

1. Laboratoire de Réactivité de Surface, Claude JOLIVALT
2. Laboratoire Interfaces et Systèmes Electrochimiques (équipe matériaux : structures et fonctionnalités),

Research project (10 lines)

The most efficient biofuel cells to date require the presence of a redox mediator, a small electro-active molecule able to shuttle electrons between the surface of the electrode and the enzymes catalysing the redox reactions occurring at electrodes. However, these mediators are always toxic and therefore hardly compatible with implantable devices. The goal of this project is to focus on the direct electron transfer between enzymes and the electrode thus avoiding the use of redox mediators. Two directions will be investigated: the first one is the development of nanostructured carbon electrodes with a high specific surface area and producing subsequently a high current density. The second one aims at controling the orientation of the enzyme covalently grafted on the electrode surface so as to optimize the direct electron transfer. The characterisation of this latter as well as diffusional limitations will be also studied by using electrochemical methods.

Summerize your scientific results & impacts (5 lines)

Two methods of functionalization of graphite cathode surface have been evaluated and studied by measuring both enzymatic activity and current density. They are based on the electrochemical reduction of a diazonium salt and the deposition of an amorphous carbon nitride thin film by cathodic magnetron pulverisation. AFM measurements have shown that the surface of the electrode is totally covered by a single layer of enzyme.

Main key facts (for instance publications / prices / oral presentations)

At short term, the goal is to characterize the influence of the grafting method of the enzyme on the kinetics of the electron transfer on the graphite electrode surface using electrochemical impedance spectroscopy and quartz crystal microbalance. In a second step, nanostructured carbon substrates offering a much larger specific area will be elaborated and tested.

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