Contact
presse.pagora@grenoble-inp.fr
Web
https://pagora.grenoble-inp.fr/en/research/media

Press release

28 April 2021

Abiotic bioelectrodes for implantable glucose biofuel cells

On March 26, 2021, Myriam Ghodhbane defended a doctoral thesis from the Université Grenoble Alpes prepared under the supervision of the Professor Naceur Belgacem (Grenoble INP-Pagora/LGP2). She presented the results of her research entitled *Fabrication and optimization of abiotic bioelectrodes for implantable glucose biofuel cells.* This work aimed at optimizing the bioelectrode's manufacturing for implantable glucose biofuel cells using different coating technics.

An abiotic catalyst composed of graphene doped with iron and nitrogen was used to make biocathodes. Two deposition methods were used to fabricate two-dimensional biocathodes: ultrasonic spraying and doctor blade coating.
The biocathodes produced by ultrasonic spraying exhibited low current densities (0.52 µA / cm^2) due to the small amounts of active material deposited. The biocathodes produced by doctor blade coating – this method makes it possible to deposit larger quantities of material – have delivered current densities of 70 µA / cm^2. These biocathodes have shown stability *in vitro* for two years. They were also implanted *in vivo* in a rat: a quasi-absence of inflammatory reaction and an ability to electro-catalyze oxygen were observed after five months of implantation.

The study then turned to the development of three-dimensional bioelectrodes. Abiotic biocathodes were produced by 3D printing, with a controlled macroporosity facilitating the diffusion of the substrate within the electrode. Two methods were applied: the use of the catalyst directly in the initial ink formulation and the creation of catalytic sites *in situ* in the 3D shape. To carry out this approach, the ink formulation and printing parameters have been optimized.
Maximum current densities of the order of 400 µA / cm^2 were obtained by the first method. The second method improved electrochemical performance (factor 1.5). This can be explained by the increase in the conductivity as well as the porosity of the bioelectrodes due to the pyrolysis step. The biocathodes from the first method were assembled in hybrid biofuel cells and implanted in the intra-abdominal region of rats. This biofuel cells remained functional even after an implantation period of three months. Over this same period, a quasi-absence of inflammatory reaction was observed, highlighting the biocompatibility of the 3D-printed biocathodes.

Finally, a study comparing two enzymatic anodes made from cellulose microfibrils (MFC) and chitosan demonstrated that the substitution of chitosan by MFC improves the anode electrochemical performance and kinetic constants.

Contact LGP2 Naceur.Belgacem@grenoble-inp.fr - **Logo** logo-lgp2.eps