Upgrade your bioreactor
All-In-One electrode for electrobiosynthesis and redox potential control

Background & Innovation
Electrochemical bioprocesses allow the biosynthesis of high-value products as a result of activities of biocatalysts like enzymes and cells. These processes are rapidly gaining relevance due to their increasing number of applications.

The yield of the reactions taking place in the bioreactor can be regulated through the adjustment of $H_2$ or $O_2$ concentration in the reaction milieu. Indeed, the electrochemical control of the reactor allows a very fine tuning of the reaction conditions.

We have developed a new type of All-In-One electrode for in situ generation of $H_2$ and $O_2$ for indirect electricity-driven biosynthesis and for the control of redox potential in bioprocesses involving microorganisms and enzymes.

Technical Description
A double-chambered electrode is designed for a flexible electrochemical splitting of water. The two internal electrodes are isolated by a ceramic membrane. All the components are integrated within a single casing, which can be coupled to the reactor using a regular 19 mm connection.

Polarisation changes allow the alternative generation of an oxidative or reductive reaction medium with a single tool. Due to the reduced space between the chambers, the pH remains constant, avoiding undesired fluctuations.

The prototype has been successfully tested on fermentations involving Clostridium pasteurianum in a 1,2 L reactor.

The conditions are fully controllable, since the electrode provides a substrate-independent electron source. Several electrodes can be used in parallel, allowing fully adaptation to the reactor and the bioprocess and enabling the upscaling of the process.

These features define a robust and versatile tool to directly influence the biocatalysts and optimise the process yield.

Potential Applications
Due to its simple working principle, based on water splitting, our new electrode is a general and versatile tool for uses in a large number of biosynthetic processes, such as:

- Aerobic and anaerobic cultures
- Enzyme-based processes
- Production of fine chemicals
- Production of biofuel
- Application in abiotic reactors

On top of these applications, our electrode is easily converted into an electrodialysis unit. This can allow the removal of organic acids from the bioprocess.

The size of the electrode, not larger than a regular pH sensor, makes it optimal for its direct implementation in existing reactors.

Customer Benefit
Our electrode represents a simple and smart solution to in situ $H_2$ and $O_2$ generation, redox potential control in the reaction, avoidance of the use of expensive membranes and pH variations when applying high voltage for electro-biosynthesis.

The control of the reaction based on electrolytic processes allows the quantitative generation of $H_2$ or $O_2$ and a very efficient distribution within the reactor.
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All-in-one electrode for redox potential fine tuning

Representative tests results generated with the electrode.

The data corresponds to electrolysis tests performed in a *C. pasteurianum* medium.

The performance of the system was tested by applying different potentials for the generation of hydrogen.

More important than the absolute energetic efficiency achieved, our new electrode achieves a very fine distribution of the generated gases within the bioreactor, thus directly influencing the bacteria.

Following parameters were monitored along the experiment:
- Energetic efficiency
- Medium pH in the reaction milieu
- Theoretical and empirical H₂ formation rate
- Faraday efficiency
- Current

Current fully-operative prototype of the electrode