Bioelectrochemical processes may replace petrochemistry lysine production

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Biofilm electrode. Credit: André Künzelmann/UFZ

Researchers at Helmholtz Center for Environmental Research (UFZ), Germany, and the University of Queensland (UQ), Australia, have found that the electrification of the white biotechnology is not merely a green dream, but an alternative to petrochemistry with realistic economical

potential. Compared to classical sugar based bio-processes, bioelectrochemical processes promise improved yields, which could turn out to be a real game changer. The next generation of bio-production facilities may not only become more environmentally friendly, but also more economically competitive, a conclusion drawn jointly by scientists at UFZ and the UQ. In a recently published study in the scientific journal ChemSusChem, the researchers analysed for the first time the economical potential of this new technology using the example of an existing bio-process.

In contrast to the energy and fuel sectors that are influenced by government targets for green alternatives, the chemical industry is mainly driven by market mechanisms. Companies and consumers are generally not prepared to pay a green premium for products. This means that compared to classical petrochemical processes, bio-production of chemicals needs to be cheaper, or in case of comparable costs, offer added value for companies to take the risk of investment into a new production process.

Nevertheless, it is expected that the share of bio-derived' green' chemicals will significantly rise over the next decade. This market is at the centre of the so called' 'white biotechnology', focussing on biotechnological processes for the production of industrial chemicals, which is distinct from medical (red) and plant (green) biotechnology.

In novel processes at lab-scale, fuels and chemicals can already be produced bio-electrochemically, using microbial synthesis driven by electricity and carbon sources.

However, achieving a broader electrification of white biotechnology is still a challenge, due to the inherently different optimal conditions for electrochemical and microbial metabolic reactions. The current knowledge gaps still require a systematic R&D effort before the

technology can be introduced more broadly, as the researchers highlight in their study.

In order to better estimate the economic potential of the new technology, the researchers used the well-established bioprocess of Lysine production and analysed how the supply of electricity as a feed for the bacteria could change the economics of this process.

Bioreactor with upgrade kit for the bioelectrochemical synthesis, Credit: André Künzelmann/UFZ

The scientists now compared the saving in raw materials costs, if the electricity would serve as a source of redox power, rather than sugar

oxidation, so that all sugar could potentially be used to build the lysine molecules. Based on different electricity prices in the EU and the US, different scenarios had to be considered. Assuming current market prices for sucrose as the main feedstock and bulk electricity charges on the two continents it was estimated that the electrically enhanced production could save costs of between 8.4% and 18 % in the EU and the US, respectively.

"This does not even consider savings in downstream processing due to a reduced production of by-products, which is expected due to the better redox balance" Dr Krömer (UQ) said.

"If one speculates further and estimates savings over a ten year horizon for a typical 50000 t p.a. plant, one would save 30 Million US$ in the EU and 50 Million US$ in the US." Dr Harnisch (UFZ) adds.

While this ignores the additional investment costs to enable the bio-electrochemistry, which can currently not be reliably estimated for large scale, this example nevertheless shows that bio-electrochemical production of chemicals can also become interesting from an economical point of view.

Bioelectrochemical technology is an approach with far reaching potential, which is supported by the fact that ChemSusChem, a journal devoted to sustainable chemistry, highlights the current study on its cover page.

More information: Harnisch, F., Rosa, L. F. M., Kracke, F., Virdis, B. and Krömer, J. O. (2014): "Electrifying White Biotechnology: Engineering and Economic Potential of Electricity-Driven Bio-Production." *ChemSusChem*. DOI: 10.1002/cssc.201402736 dx.doi.org/10.1002/cssc.201402736