Better than nature: artificial biofilm increases energy production in microbial fuel cells

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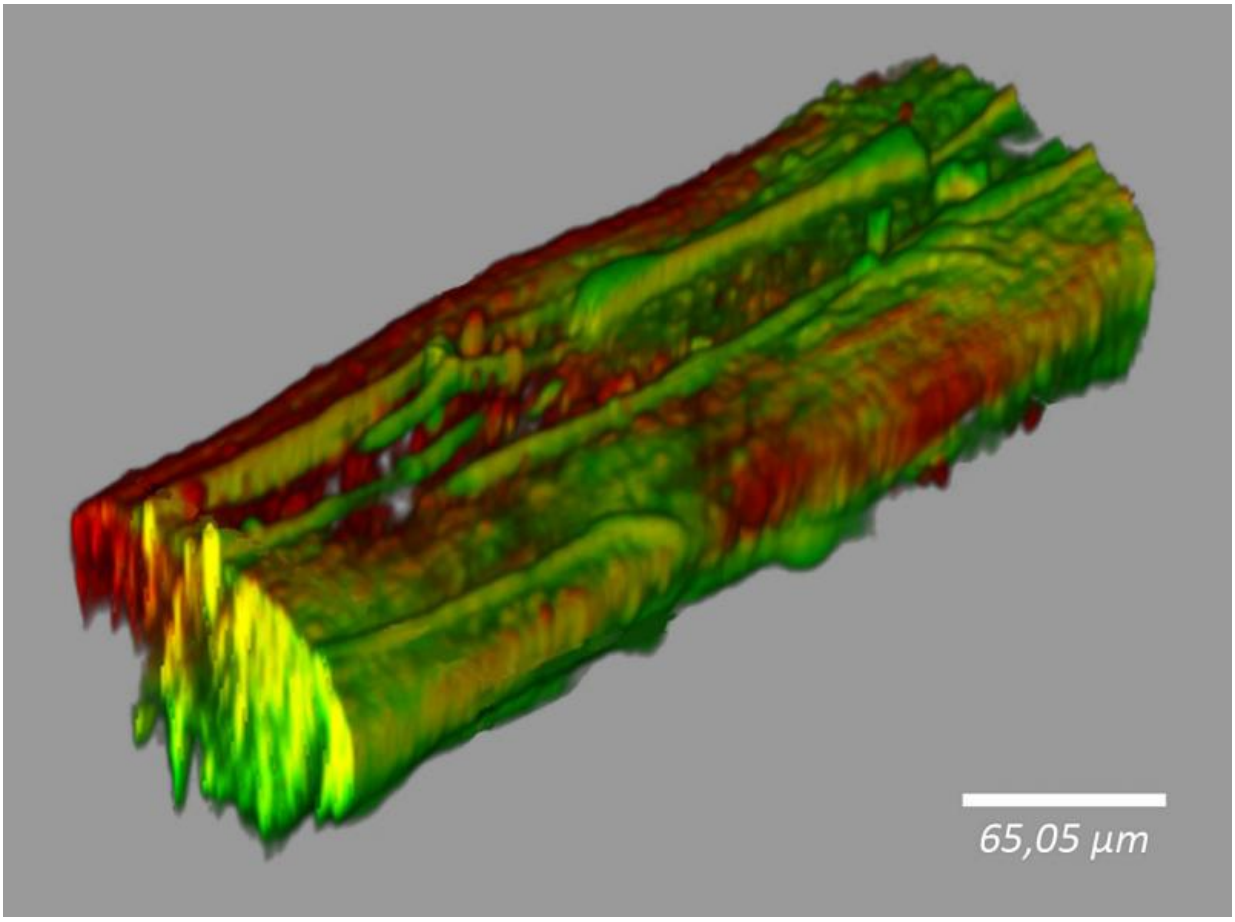

A confocal microscopic image of wet spun microfibres with Shewanella oneidensis bacteria (green: living bacteria; red: dead bacteria). Credit: Patrick Kaiser

Microbial fuel cells exploit the metabolism of bacteria in order to generate electricity. A new type of biofilm developed in Bayreuth could soon make this relatively young technology considerably more effective, more stable, and easier to use. A research team at the University of Bayreuth has succeeded in producing a material that is far better suited for energy production in fuel cells than natural biofilms. The scientists described the advantages of their new findings in the journal *Macromolecular Bioscience*.

Bacteria in microbial fuel cells feed on organic substances such as lactic acid. In this context, electrons are continuously released as part of the metabolic process. As soon as these electrons come into contact with the anode of the fuel cell, they are transferred to the cathode on the opposite side. This creates an electric current. Until now, when generating electricity in this way, the metallic surface of the anode has generally been colonized by bacteria. The bacteria multiply there, eventually creating a natural biofilm and transferring electrons to the anode. The newly developed artificial biofilm from Bayreuth has the same effect, but optimizes this type of energy production in several ways.

Bacteria in synthetic nets: more stable than natural biofilms

The material developed by the research group led by Prof. Dr. Ruth Freitag (Process Biotechnology) and Prof. Dr. Andreas Greiner (Macromolecular Chemistry) is a biocomposite: a hydrogel, to be exact. It is a network of tiny polymer fibres containing a single type of bacteria, the metabolisms of which can continue generating power without interruption. However, the amount of power produced is considerably higher: "Our biofilm contains only one type of bacteria, namely Shewanella oneidensis. The electrical performance of a fuel cell with this film is twice as high as when bacteria of this species produce a

natural biofilm," explained Patrick Kaiser (M.Sc.), a doctoral researcher in Bayreuth and one of the authors of the recently published study.

There is also a further advantage to this performance enhancement: energy is produced reliably and predictably, since the concentration of bacteria is determined from the outset in the artificial biofilm. In contrast, natural biofilms are released in a way that is difficult to control, making them less stable. The Bayreuth scientists' new biocomposite thus makes fuel cells considerably easier to use.

The biocomposite was produced on the campus of the University of Bayreuth via the electro-spinning of polymer fibres that combine to form a fleece. "Nowadays, electro-spinning of fleece is a widely used technology. No additional production steps are required to embed the bacteria," added Steffen Reich (M.Sc.), who wrote his doctoral thesis in Bayreuth on the encapsulation of bacteria in polymers.

More information: Patrick Kaiser et al. Electrogenic Single-Species Biocomposites as Anodes for Microbial Fuel Cells, *Macromolecular Bioscience* (2017). DOI: 10.1002/mabi.201600442

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