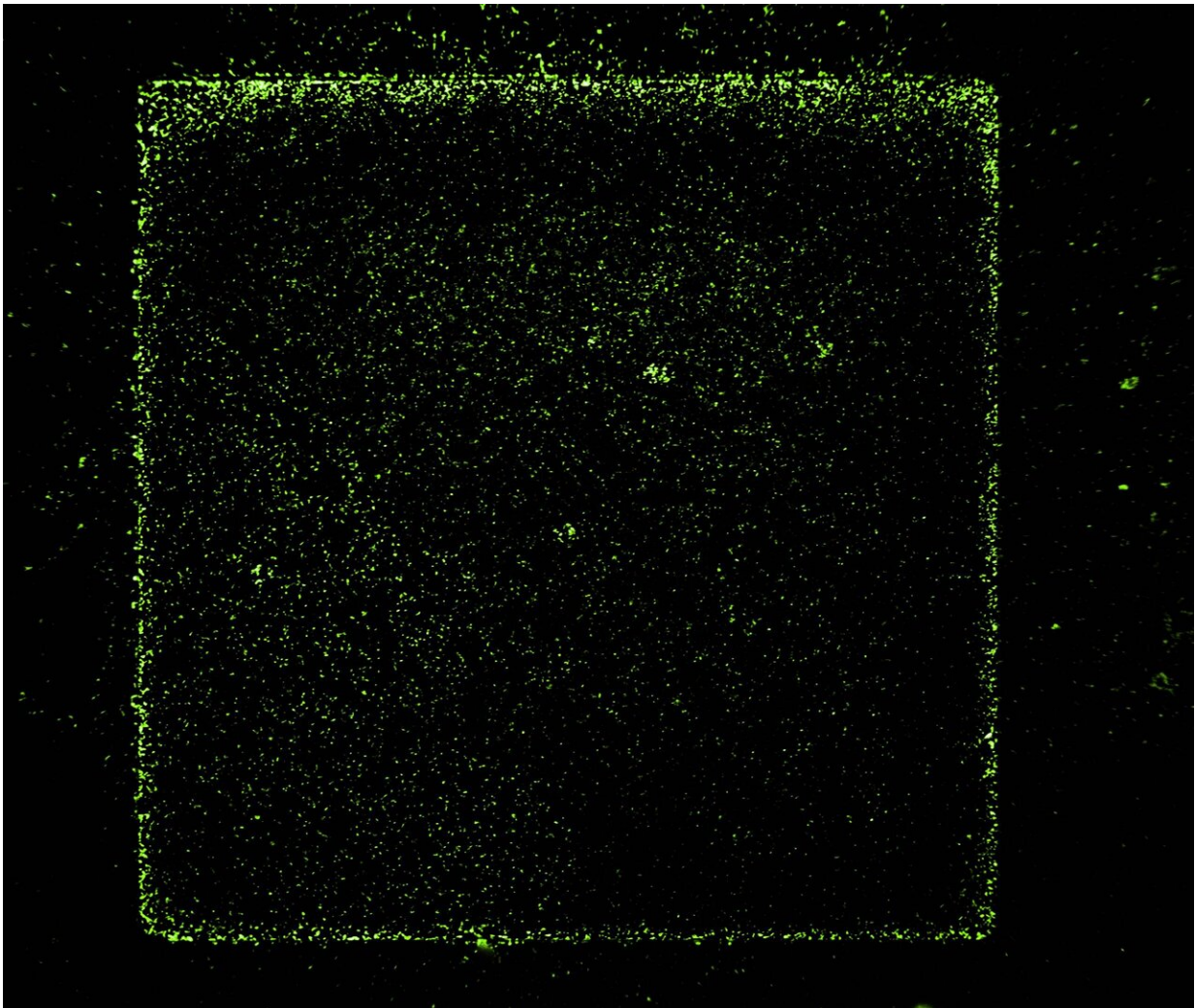


Using tiny electrodes to measure electrical activity in bacteria

June 17 2020



Bacteria sitting on the gate electrode, viewed by a fluorescence microscope.
Credit: Thor Balkhed

Scientists at Laboratory of Organic Electronics, Linköping University, have developed an organic electrochemical transistor that they can use to measure and study in fine detail a phenomenon known as extracellular electron transfer in which bacteria release electrons.

The study of bacteria and their significance for the natural world, and for [human society](#) and health, is a growing research field, as new bacteria are continuously being discovered. A [human body](#) contains more bacteria than [human cells](#), and a milliliter of fresh water can hold as many as a million bacteria. Respiration in a normal human cell and in many bacteria takes place through biochemical reactions in which a compound, often glucose, reacts with oxygen to form carbon dioxide and water. During the process, energy is converted to a form that the cell can use. In oxygen-free environments, bacteria are found that metabolize organic compounds, like lactate, and instead of forming water, they release, or respire, electric charges, a byproduct of metabolism, into the environment. The process is known as extracellular electron transfer, or extracellular respiration.

The phenomenon is currently used in several electrochemical systems in applications such as water purification, biosensors and fuel cells. Adding bacteria is an eco-friendly way to convert chemical energy to electricity.

One such bacteria often used in research is *Shewanella oneidensis*, which previous research has shown to produce electrical current when fed with arsenic, arabinose (a type of sugar) or organic acids. A similar bacterium has recently been discovered in the human gastrointestinal system.



The organic electrochemical transistor in which the researchers have been able to deposit *Shewanella oneidensis* on one of the microelectrodes. Credit: Thor Balkhed

We do not, however, understand in detail what happens when bacteria release charges. In order to capture and measure the amount of charge released, electrodes are placed into the microbial systems. An individual bacterium gives a very [weak signal](#), and thus until now, researchers have had to be satisfied with studying extracellular electron transfer in large systems with large numbers of bacteria.

Scientists at the Laboratory of Organic Electronics at Linköping University have employed a combination of microelectronics, electrochemistry and microbiology to understand electrical activity in bacteria. They have developed an [organic electrochemical transistor](#) in which they have been able to deposit *Shewanella oneidensis* on one of

the microelectrodes, with a surface area of only a quarter of a square millimeter. The amplification of the signal that occurs in the transistor makes it possible for them to study in detail what happens when various substances are added to the system. They describe experiments in which they fed lactate to the bacteria in an article in *Advanced Science*.

"We have shown that we can detect very small differences in extracellular electron transfer, in other words the amount of charge released by the bacteria. Another plus is that we can achieve very short response times, and obtain a stable signal within ten minutes," says principal research engineer Gábor Méhes, who, together with senior lecturer Eleni Stavriniidou, is corresponding author for the article.

"This is a first step towards understanding extracellular electron transfer in bacteria occupying only a small area with the help of a transistor, and how the conversion takes place between the bacteria and the electrode," says Gábor Méhes. "One future goal is to learn how [bacteria](#) interact with each other, and with other cells and chemical substances in the human gastrointestinal tract."

More information: Gábor Méhes et al. Organic Microbial Electrochemical Transistor Monitoring Extracellular Electron Transfer, *Advanced Science* (2020). [DOI: 10.1002/advs.202000641](https://doi.org/10.1002/advs.202000641)

Provided by Linköping University

Citation: Using tiny electrodes to measure electrical activity in bacteria (2020, June 17) retrieved 27 April 2024 from <https://phys.org/news/2020-06-tiny-electrodes-electrical-bacteria.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is

provided for information purposes only.