Conducting shell for bacteria

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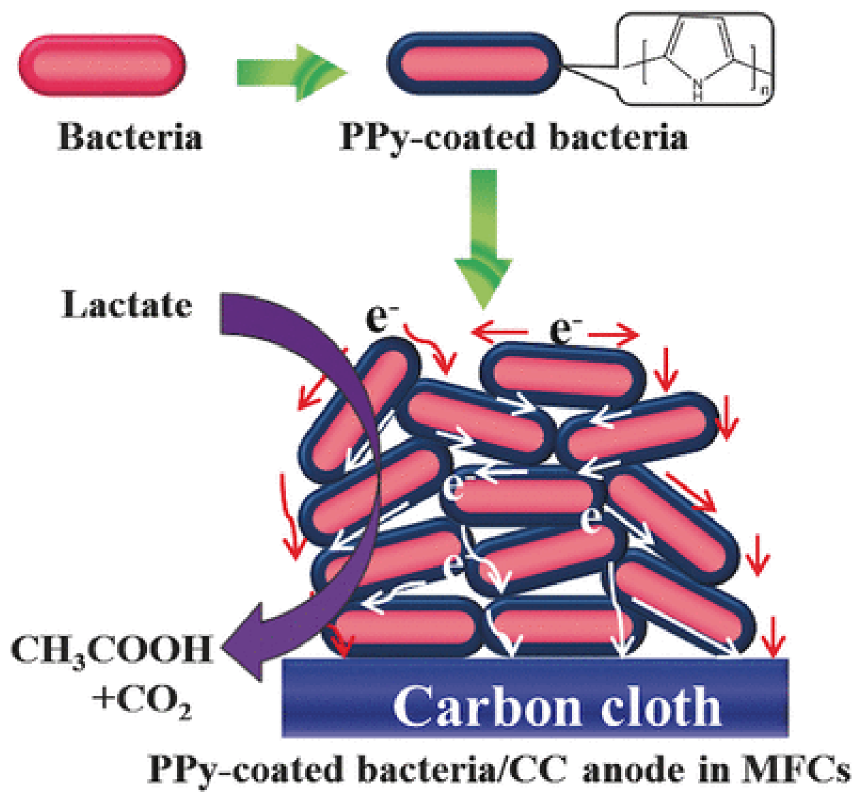

Credit: Wiley

Under anaerobic conditions, certain bacteria can produce electricity. This behavior can be exploited in microbial fuel cells, with a special focus on wastewater treatment schemes. A weak point is the dissatisfactory power density of the microbial cells. An unconventional solution is now presented by Singaporean and Chinese scientists: as reported in the journal *Angewandte Chemie*, they coated live, electroactive bacteria with a conducting polymer and obtained a high-performance anode for microbial fuel cells.

The history of microbial fuel cells goes back to the beginning of the 20th century when scientists connected bacteria cells with electrodes to generate electricity. The principle is that, if no oxygen is present, the bacteria's metabolism changes to produce protons and electrons instead of carbon dioxide and water. These electrons can be used for current generation in an electrochemical cell. Such microbial fuel cells are currently heavily investigated for sustainable energy production and, especially, wastewater treatment. Their weak point is the power density. Much of the electrochemical potential of the bacteria is wasted because they do not transmit their produced electrons easily to the electrode. To make them more conductive, Qichun Zhang from Nanyang Technological University, Singapore, and his colleagues explored the idea of wrapping bacteria in a shell of electron-conducting polymers. The challenge with this is that the coated bacteria must still be viable.

The scientists relied on the polymer polypyrrole. "The modification of bacterial cells with polypyrrole is anticipated to improve the electrical conductivity of bacterial cells without reducing their viability," the authors explained. Iron ions were employed as "the oxidative initiator to make pyrrole monomers polymerized on the [bacterium's] surface." The organism of choice was the proteobacterium Shewanella oneidensis, which is known for its metal toleration and both aerobic and anaerobic lifestyles. Still living and active, the coated bacteria were tested for biocurrent generation with a carbon anode. Compared to their unmodified counterparts, they indeed displayed a 23 times smaller resistance (which means, enhanced conductivity), a fivefold increase in electricity generation, and a 14 times higher maximum power density of the anode in a microbial fuel cell. And if the bacteria were fed with lactate, the authors observed a pronounced current, which did not happen when uncoated bacteria were used.

Zhang's approach is a remarkable solution to the conductivity problem of a microbial anode. The authors believe that this coating scheme of live bacteria may add a new dimension to the exploration of microbial fuel cells, as well as general research on cell-surface functionalization.

More information: Rong-Bin Song et al, Living and Conducting: Coating Individual Bacterial Cells with In Situ Formed Polypyrrole, *Angewandte Chemie International Edition* (2017). DOI: 10.1002/anie.201704729

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