Microbial Fuel Cells Generate Energy While Clearing Biowaste from Water

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Technology Summary

Developing the technology to generate energy from waste and renewable materials is becoming an increasingly important priority in the United States, as energy derived from fossil fuels is both expensive and environmentally harmful. Microbial fuel cells are an emerging technology for producing electricity directly from biodegradable matter such as organic acids and sugars.

An ORNL research team has developed a microbial fuel cell that features an enriched biocatalyst, made from colonies of microbes, capable of producing electricity from multiple carbon sources. The fuel cell stores the excess carbon internally and subsequently uses that stored carbon to produce electricity.

Microbial fuel cells are known to be promising devices for the production of electricity, but the power output has been limited by proton and electron transfer from the anode biocatalyst to the cathode. Until now, the highest power output obtained from microbial fuel cells is in the range of 258–271 W/m^3, achieved using an enriched biocatalyst but not eliminating planktonic organisms or screening for specific traits.

The researchers improved the biocatalyst to perform more efficient electron transfer to the electrode in a two-step process. Since plankton's electron mediators do not adhere well to the electrodes, researchers first removed these organisms from the biofilm-forming organisms. In a second step, the bio-organisms were enriched by removing the carbon source from the feed stream after an initial growth phase in the biocatalyst, and then allowing the biocatalyst to operate under carbon starvation conditions for some days, so that it would become rich in organisms capable of using internally stored carbon as the carbon source.

In this way, the enriched biocatalyst became capable of storing excess carbon internally, and using this internal carbon for electricity production in the absence of organic carbon in the liquid stream.

The procedure results in a biocatalyst that can produce electricity at high power densities, about 43 to 50% higher than previously reported. In addition to having a high power density, the biocatalyst is capable of handling liquid streams that feature large fluctuations in the flow rate, as well as carbon loading.

Advantages

This new microbial fuel cell technology has a twofold benefit: First, the enriched biocatalyst is commercially attractive as a treatment for wastewaters that exhibit high biological oxygen demand; second, this treatment technology directly generates electricity from biological waste.

Potential Applications

An important application of microbial fuels cells is in wastewater treatment. The organic carbon waste can be removed, and electricity is produced. A biocatalyst enriched in wastewater can produce electricity continuously and safely.

Industries that produce wastewaters high in easily degradable organic carbon are good candidates for this application. Examples include the food industry, dairies, breweries, the bioproducts industry, and the biofuels industry, such as biorefineries.

Patent

Abhijeet P. Borole, *Microbial Fuel Cell with Improved Anode,* U.S. Patent 7,695,834, issued April 13, 2010.

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