fuelcellworks

|Archives| Charts| Companies/Links| Conferences| How A Fuel Cell Works | Patents| | Types of Fuel Cells | The Basics | Fuel Cell News | Basics on Hydrogen | Search|

Fuel cell power

Publication Date:06-June-2006
01:00 PM US Eastern Timezone
Source:ISA

Microbe-powered electricity generation is getting much closer, as the output of microbial fuel cells jumped more than 10-fold by letting the bacteria congregate into a slimy matrix known as a biofilm.

A typical fuel cell converts fuels to electricity without the need for combustion, and microbial fuel cells work the same way. They usually consist of two compartments, or cells, separated by an electrically insulating membrane. In one compartment, microorganisms pull electrons and protons from some sort of fuel, such as waste organic matter. These protons and electrons head toward the molecules in the second compartment, usually oxygen. The protons do this by passing through the membrane. But the electrons can't go through the membrane and so must travel via an alternate route—a wire, or electrode that connects the two compartments. It is this flow of electrons through the electrode that supplies power.

Microbial fuels cells harness the electron shuttling that occurs in the energy-making pathway of certain bacteria. In the energy-making pathway of most animals, electrons and protons also shuttle about, and usually electrons pass to oxygen brought in through the lungs. Early microbial fuel cells intercepted the bacteria's electron shuttling with compounds called "mediators," which would penetrate the bacteria, snatch electrons, and then transfer them to the metal electrode. But the compounds typically used as mediators are often expensive and toxic. A more efficient approach has been to use microbes that can pass electrons directly to a metal electrode.

These "metal-reducing" bacteria are ideal for fuel cells, said microbiologist Derek Lovley of the University of Massachusetts Amherst, especially species of Geobacter and Rhodoferax, microbes that evolved means to transfer electrons to metals in the surrounding environment. The microbes use thin wire-like growths, several cell lengths long, that extend from their cell membrane out into the environment. Many bacteria have these extended structures called pili. They usually use the hair-like extensions to attach to other cells or surfaces. But Geobacter uses pili to transfer electrons onto iron in the surrounding soil. These "microbial nanowires" also seem to be critical for Geobacter to form a biofilm, Lovley said.

While investigating the microbes' electron transfer mechanism, Lovley's team created a mutant Geobacter that didn't have the gene for making the pili, yet the microbes still produced electricity when placed in a fuel cell. The researchers suspected a membrane protein that was part of the microbe's energy-making pathway was also able to transfer electrons directly to the metal electrode.

"The microbes were lined up in a single, thin layer along the electrode," Lovley said. "It seemed that either the nanowires or the membrane protein had to be in direct contact with the electrode for electron transfer to occur."

But then the researchers tweaked their fuel cell so the second compartment could take as many electrons as the microbes could provide. To the scientists' surprise, the power output increased dramatically, and Geobacter began to grow on the electrode in a thick, sticky mass known as a biofilm. However, the mutant Geobacter that couldn't make pili couldn't congregate into a biofilm.

"The mutants produced electricity at a much slower rate" Lovley said. "It seems that Geobacter's pili are essential for making a biofilm."

Different types of bacteria form biofilms; the gluey matrix of sugars serves to anchor freefloating microbes to various surfaces. Biofilm, in this case, seems to act as one big, slimy, conductive mat, allowing electrons to transfer by bacteria that aren't in direct contact with the electrode.

HOME