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Sugar fuel cell can lead to self-powered brain implants - The Times of India

MIT engineers led by an Indian origin researcher have developed a fuel cell that runs on the same sugar that powers human cells: glucose.

This glucose fuel cell could be used to drive highly efficient brain implants of the future, which could help paralyzed patients move their arms and legs again.

The fuel cell strips electrons from glucose molecules to create a small electric current.

Rahul Sarpeshkar, an associate professor of electrical engineering and computer science at MIT, and colleagues fabricated the fuel cell on a silicon chip, allowing it to be integrated with other circuits that would be needed for a brain implant.

The idea of a glucose fuel cell is not new: In the 1970s, scientists showed they could power a pacemaker with a glucose fuel cell, but the idea was abandoned in favor of lithium-ion batteries, which could provide significantly more power per unit area than glucose fuel cells.

These glucose fuel cells also utilized enzymes that proved to be impractical for long-term implantation in the body, since they eventually ceased to function efficiently.

The new twist to the MIT fuel cell is that it is fabricated from silicon, using the same technology used to make semiconductor electronic chips.

The fuel cell has no biological components: It consists of a platinum catalyst that strips electrons from glucose, mimicking the activity of cellular enzymes that break down glucose to generate ATP, the cell's energy currency. (Platinum has a proven record of long-term biocompatibility within the body.) So far, the fuel cell can generate up to hundreds of microwatts — enough to power an ultra-low-power and clinically useful neural implant.

"It will be a few more years into the future before you see people with spinal-cord injuries receive such implantable systems in the context of standard medical care, but those are the sorts of devices you could envision powering from a glucose-based fuel cell," said Benjamin Rapoport, a former graduate student in the Sarpeshkar lab and the first author on the new MIT study.

Rapoport calculated that in theory, the glucose fuel cell could get all the sugar it needs from the cerebrospinal fluid (CSF) that bathes the brain and protects it from banging into the skull.

There are very few cells in the CSF, so it's highly unlikely that an implant located there would provoke an immune response. There is also significant glucose in the CSF, which does not generally get used by the body. Since only a small fraction of the available power is utilized by the glucose fuel cell, the impact on the brain's function would likely be small.

Karim Oweiss, an associate professor of electrical engineering, computer science and neuroscience at Michigan State University, said the work is a good step toward developing implantable medical devices that don't require external power sources.

"It's a proof of concept that they can generate enough power to meet the requirements," stated Oweiss, adding that the next step will be to demonstrate that it can work in a living animal.

Sarpeshkar's group is a leader in the field of ultra-low-power electronics, having pioneered such designs for cochlear implants and brain implants.

"The glucose fuel cell, when combined with such ultra-low-power electronics, can enable brain implants or other implants to be completely self-powered," said Sarpeshkar.

The development was described in the June 12 edition of the journal PLoS ONE.