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The Republican.

UMass research team plugged into geobacters

Friday, July 08, 2005

By STAN FREEMAN
sfreeman@repub.com

AMHERST - To make extremely tiny things, you may need extremely tiny workers.

And with electronic circuitry getting ever smaller, a research team at University of Massachusetts at Amherst may have discovered where the labor force to produce microcircuitry and other nanoelectronic devices will come from in the future.

It may be from underground.

In an article in the June issue of Nature, UMass microbiologist Derek R. Lovley and his team detailed how a family of energy-harvesting, subterranean bacteria, called geobacters, produces wire-like appendages that can conduct electricity.

These "nanowires" are incredibly fine, nearly 20,000 times finer than a human hair. But they are very durable and more than a thousand times longer than they are wide, researchers found.

"Such long, thin conductive structures are unprecedented in biology," Lovley said. "This completely changes our concept of how microorganisms can handle electrons, and it also seems likely that microbial nanowires could be useful materials for the development of extremely small electronic devices.

"Unfortunately, at this stage, the application to nanoelectronics is speculative but the potential is certainly there. Each geobacter makes multiple wires and you can grow billions of geobacters, so this might be a convenient way to produce a lot of tiny electrical structures," he said.

That's assuming you can find a way to harvest all those tiny wires. Lovley said that is not part of his research at the moment, but it may be one day.

Lovley discovered geobacters in 1987 in the sediment of the Potomac River but has since found them in other environments underground that lack oxygen. While humans and most other living things use oxygen to create energy, geobacters produce energy using the iron naturally present in soil.

The bacteria break down the iron compounds. In the process, they transfer electrons from inside their cells to the surrounding environment, via the nonowires. If a conducting metal is placed amid the bacteria, those transferred electrons will create a flow of electricity in the metal.

UMass researchers believed the electrons in the cells of the geobacters were transferred to metals in the surrounding environment through the nanowires, called pili.

To test this hypothesis, UMass microbiologist Gemma Ruegera teamed with UMass physicists Mark T. Tuominen and Kevin D. McCarthy to probe nanowires with a powerful microscope capable of showing structures at the level of the atom. They found that pili were good conductors of electricity.

Furthermore, when geobacters were genetically modified to prevent them from producing pili, the bacteria could no longer transfer electrons to their surroundings, researchers found.

Lovley's team is trying to decipher the genetic structure of geobacters in order to figure out how conducting wires are created. Understanding the genetic underpinning may allow scientists to reproduce the biological wires in other ways so they can be more readily used in nanoelectronic applications.

Authors of the Nature article were Lovley, Reguera, McCarthy and Tuominen as well as UMass microbiologists Teena Mehta and Julie S. Nicoll.

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