Popeye Power May Energize Tomorrow's Electronics

By Mike Martin
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An MIT team has used spinach chloroplasts -- cells that make energy from sunlight via photosynthesis -- to make "the smallest electronic circuits I know of," MIT assistant professor Marc Baldo says.

The Popeye Principle may one day power cell phones and laptops, say researchers at MIT, who have used spinach -- the superhero sailor's fave food -- to power a tiny electronic circuit.

Going green may be a trend among Earth-conscious companies, but the practice has posed numerous dilemmas for electrical engineers that long to harvest the power of plants.

EE is Green's Middle Name

How to marry agro and electro has stymied researchers. Water and salt -- critical to the survival of plant life -- normally would kill an electronic device.

But now "we have crossed the first hurdle of successfully integrating a photosynthetic protein molecular complex with a solid-state electronic device," said Marc Baldo, assistant professor of electronic engineering and computer science at MIT.

The MIT team used spinach chloroplasts -- cells that make energy from sunlight via photosynthesis -- to make "the smallest electronic circuits I know of," Baldo told NewsFactor.

Spinach -- as wise old Popeye has known for 75 years -- produces a lot of photosynthetic energy relative to its size and weight.

At the spinach circuit's center is a 10 to 20 nanometer-wide protein complex called "Photosystem I" (PSI) that would fit 100,000 to the head of a pin.

Soap Opera

The MIT team used a so-called "peptide surfactant" -- similar to the main ingredient in soap -- to stabilize the photosynthetic PSI complex while the circuit was fabricated.

"The researchers ground up ordinary spinach and purified it with a centrifuge to isolate a protein deep within the cell," said MIT spokesperson Denise Brehm. "The resulting dark green pellets smell like cut grass."

Keeping the protein pellets pliable and functional presented a challenge.

The new surfactant -- a "designer nano-material" -- turned out to be ideal for keeping the pellets functional without water on a cold, hard surface, such as the top of an electronic circuit board.

"The detergent peptide turned out to be a wonderful material to keep proteins intact on the surface with electronics," said Shuguang Zhang, associate director of MIT's Center for Biomedical Engineering, who discovered that these soap-like peptides can be used to perform useful functions in electronics.

Spinach Sandwich

The finished spinach-powered circuit resembled a sandwich.

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The bottom layer is transparent glass coated with a conductive material. A thin layer of gold helps the chemical reaction that assembles the spinach chlorophyll Photosystem I complexes. The researchers then evaporate a soft, organic semiconductor that prevents electrical shorts and protects the protein complexes from the layer of metal that completes the sandwich.

Using laser light to excite the photosynthetic molecules, the researchers measured the resulting current.

"Of the light that was absorbed, we estimate that we converted around 12 percent to charge," Baldo said. "We got very little current out, mostly because we had just a thin layer of the complexes in our devices."

The researchers hope to achieve a power conversion efficiency of 20 percent or more, which would provide an extremely efficient power source, MIT's Brehm told NewsFactor.

Hopefully well before Popeye's 100th birthday, the researchers plan to concentrate layers of PSI on rough or 3-D surfaces, like skyscrapers that create a large amount of surface area within a relatively small space.

The work was recently reported in NanoLetters, a publication of the American Chemical Society.

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