Developing Artificial Retina: Electric Link Between Neurons, Light-Sensitive Nanoparticle Films Created

February 27 2007

The world's first direct electrical link between nerve cells and photovoltaic nanoparticle films has been achieved by researchers at the University of Texas Medical Branch at Galveston (UTMB) and the University of Michigan. The development opens the door to applying the unique properties of nanoparticles to a wide variety of light-stimulated nerve-signaling devices — including the possible development of a nanoparticle-based artificial retina.

Nanoparticles are artificially created bits of matter not much bigger than individual atoms. Their behavior is controlled by the same forces that shape molecules; they also exhibit the bizarre effects associated with quantum mechanics. Scientists can exploit these characteristics to custom-build new materials "from the bottom up" with characteristics such as compatibility with living cells and the ability to turn light into tiny electrical currents that can produce responses in nerves.

That's what the UTMB and Michigan researchers did, using a process devised by Michigan chemical engineering professor Nicholas Kotov, one of the authors of a paper on the research appearing in the current issue of *Nano Letters*. The process starts with a glass plate and then builds a layer-by-layer sandwich of two kinds of ultra-thin films, one made of mercury-tellurium nanoparticles and another of a positively charged polymer called PDDA. The scientists then added a layer of ordinary clay and a cell-friendly coating of amino acid, and placed cultured neurons on the very top.

When light shines on them, the mercury-tellurium nanoparticle film layers produce electrons, which then move up into the PDDA film layers and produce an upward-moving electrical current. "As you build up the layers of this, you get better capabilities to absorb photons and generate voltage," said UTMB research scientist Todd Pappas, lead author on the Nano Letters paper. "When the current reaches the neuron membrane, it depolarizes the cell to the point where it fires, and you get a signal in the nerve."

Although light signals have previously been transmitted to nerve cells using silicon (whose ability to turn light into electricity is employed in solar cells and in the imaging sensors of video cameras), nanoengineered materials promise far greater efficiency and versatility.

"It should be possible for us to tune the electrical characteristics of these nanoparticle films to get properties like color sensitivity and differential stimulation, the sort of things you want if you're trying to make an artificial retina, which is one of the ultimate goals of this project," Pappas said. "You can't do that with silicon. Plus, silicon is a bulk material — silicon devices are much less size-compatible with cells."

The researchers caution that despite the great potential of a light-sensitive nanoparticle-neuron interface, creating an actual implantable artificial retina is a long-range project. But they're equally hopeful about a variety of other, less complex applications made possible by a tiny, versatile light-activated interface with nerve cells — such things as new ways to connect with artificial limbs and other prostheses, and revolutionary new tools for imaging, diagnosis and therapy.

"The beauty of this achievement is that these materials can be remotely activated without having to use wires to connect them. All you have to do is deliver light to the material," said Professor Massoud Motamedi, director of UTMB's Center for Biomedical Engineering and a co-author of the paper. "This type of technology has the ability to provide non-invasive connections between the human nervous system and prostheses and instruments that are unprecedented in their flexibility, compactness and reliability," Motamedi continued. "I feel that such nanotools are going to give the fields of medicine and biology brand-new capabilities that it's hard to even imagine now."

Source: University of Texas Medical Branch at Galveston

Citation: Developing Artificial Retina: Electric Link Between Neurons, Light-Sensitive Nanoparticle Films Created (2007, February 27) retrieved 9 April 2024 from https://phys.org/news/2007-02-artificial-retina-electric-link-neurons.html