Injectable nanoelectronics for treatment of neuro-degenerative diseases

(Nanowerk News) It's a notion that might be pulled from the pages of science-fiction novel - electronic devices that can be injected directly into the brain, or other body parts, and treat everything from neurodegenerative disorders to paralysis.

It sounds unlikely, until you visit Charles Lieber's lab.

A team of international researchers, led by Lieber, the Mark Hyman, Jr. Professor of Chemistry, an international team of researchers developed a method for fabricating nano-scale electronic scaffolds that can be injected via syringe. Once connected to electronic devices, the scaffolds can be used to monitor neural activity, stimulate tissues and even promote regenerations of neurons. The study is described in a June 8 paper in Nature Nanotechnology ("Syringe-injectable electronics").

Contributing to the work were Jia Liu, Tian-Ming Fu, Zengguang Cheng, Guosong Hong, Tao Zhou, Lihua Jin, Madhavi Duvvuri, Zhe Jiang, Peter Kruskal, Chong Xie, Zhigang Suo, Ying Fang
Injectable nanoelectronics for treatment of neuro-degenerative diseases

Photograph showing injection of mesh electronics through a metal needle into aqueous solution. Although the electronics appears to be a film at this (low) resolution, it is an open mesh structure. (Image: Lieber Research Group, Harvard University)

"I do feel that this has the potential to be revolutionary," Lieber said. "This opens up a completely new frontier where we can explore the interface between electronic structures and biology. For the past thirty years, people have made incremental improvements in micro-fabrication techniques that have allowed us to make rigid probes smaller and smaller, but no one has addressed this issue - the electronics/cellular interface - at the level at which biology works."

The idea of merging the biological with the electronic is not a new one for Lieber.

In an earlier study, scientists in Lieber's lab demonstrated that the scaffolds could be used to create "cyborg" tissue - when cardiac or nerve cells were grown with embedded scaffolds. Researchers were then able to use the devices to record electrical signals generated by the tissues, and to measure changes in those signals as they administered cardio- or neuro-stimulating drugs.

"We were able to demonstrate that we could make this scaffold and culture cells within it, but we didn't really have an idea how to insert that into pre-existing tissue," Lieber said. "But if you want to study the brain or develop the tools to explore the brain-machine interface, you need to stick something into the body. When releasing the electronics scaffold completely from the fabrication substrate, we noticed that it was almost invisible and very flexible like a polymer and could literally be sucked into a glass needle or pipette. From there, we simply asked, would it be possible to deliver the mesh electronics by syringe needle injection, a process common to delivery of many species in biology and medicine - you could go to the doctor and you inject this and you're wired up."

Injectable nanoelectronics for treatment of neuro-degenerative diseases


Bright-field image showing the mesh electronics being injected through sub-100 micrometer inner diameter glass needle into aqueous solution. (Image: Lieber Research Group, Harvard University)

Though not the first attempts at implanting electronics into the brain - deep brain stimulation has been used to treat a variety of disorders for decades - the nano-fabricated scaffolds operate on a completely different scale. Zhe Jiang, Peter Kruskal, Chong Xie, Zhigang Suo, Ying Fang

"Existing techniques are crude relative to the way the brain is wired," Lieber explained. "Whether it's a silicon probe or flexible polymers...they cause inflammation in the tissue that requires periodically changing the position or the stimulation. But with our injectable electronics, it's as if it's not there at all. They are one million times more flexible than any state-of-the-art flexible electronics and have subcellular feature sizes. They're what I call "neuro-philic" - they actually like to interact with neurons."

Despite their enormous potential, the fabrication of the injectable scaffolds is surprisingly easy.

"That's the beauty of this - it's compatible with conventional manufacturing techniques," Lieber said.

The process is similar to that used to etch microchips, and begins with a dissolvable layer deposited on a substrate. To create the scaffold, researchers lay out a mesh of nanowires sandwiched in layers of organic polymer. The first layer is then dissolved, leaving the flexible mesh, which can be drawn into a syringe needle and administered like any other injection.

After injection, the input/output of the mesh can be connected to standard measurement electronics so that the integrated devices can be addressed and used to stimulate or record neural activity.

Three-dimensional confocal microscopy image of mesh electronics injected into the lateral ventricle, and illustrating the unique integration with and innervation of the neural tissue, as well as the migration of neural progenitor cells on to the mesh within the cavity. (Image: Lieber Research Group, Harvard University)

"These type of things have never been done before, from both a fundamental neuroscience and medical perspective," Lieber said. "It's really exciting - there are a lot of potential applications."

Going forward, Lieber said, researchers hope to better understand how the brain and other tissues react to the injectable electronics over longer periods.

Harvard's Office of Technology Development has filed for a provisional patent on the technology and is actively seeking commercialization opportunities.

"Having those results can prove that this is really a viable technology," Lieber said. "The idea of being able to precisely position and record from very specific areas, or even from specific neurons over an extended period of time - this could, I think, make a huge impact on neuroscience."
Injectable nanoelectronics for treatment of neuro-degenerative diseases

Source: Harvard University

If you liked this article, please give it a quick review on reddit or StumbleUpon. Thanks!

0 Comments  Nanowerk

Love Recommend  Share

Start the discussion…

Be the first to comment.

Check out these other trending stories on Nanowerk:

Growing eyes from stem cells
Curcumin nanodrug breaks cancers' resistance to treatment
One step closer to a single-molecule device
Nanotechnology and Emerging Technologies - Nanoscience News from Nanowerk
Physicists solve quantum tunneling mystery
Scientists print low cost radio frequency antenna with graphene ink
Expanding the code of life with new 'letters'

Source: Harvard University

If you liked this article, please give it a quick review on reddit or StumbleUpon. Thanks!

0 Comments  Nanowerk

Love Recommend  Share

Start the discussion…

Be the first to comment.

Check out these other trending stories on Nanowerk:

Growing eyes from stem cells
Curcumin nanodrug breaks cancers' resistance to treatment
One step closer to a single-molecule device
Nanotechnology and Emerging Technologies - Nanoscience News from Nanowerk
Physicists solve quantum tunneling mystery
Scientists print low cost radio frequency antenna with graphene ink
Expanding the code of life with new 'letters'

Source: Harvard University

If you liked this article, please give it a quick review on reddit or StumbleUpon. Thanks!

0 Comments  Nanowerk

Love Recommend  Share

Start the discussion…

Be the first to comment.

Check out these other trending stories on Nanowerk:

Growing eyes from stem cells
Curcumin nanodrug breaks cancers' resistance to treatment
One step closer to a single-molecule device
Nanotechnology and Emerging Technologies - Nanoscience News from Nanowerk
Physicists solve quantum tunneling mystery
Scientists print low cost radio frequency antenna with graphene ink
Expanding the code of life with new 'letters'

Source: Harvard University

If you liked this article, please give it a quick review on reddit or StumbleUpon. Thanks!

0 Comments  Nanowerk

Love Recommend  Share

Start the discussion…

Be the first to comment.
‘Nan-raspberries’ could bear fruit in fuel cell...improving energy storage with a cue from nature
Posted: Jun 09, 2015

Filming the film: Scientists observe photographic exposure live at the nanoscale
Physicists develop ultrasensitive nanomechanical biosensor
Posted: Jun 09, 2015

Engineers develop a computer that operates on water droplets (w/video)
Ultrasensitive magnetoplasmonic sensors with nano-antennas
Posted: Jun 09, 2015

Closing in on the phenomenon of superconductivity with a two-dimensional atomic gas
A step towards a Type 1 Diabetes vaccine by using nanotherapy
Posted: Jun 09, 2015

3D nano-images reveal 'bicycle spoke' structure of heart cells that may hold key heart attack clues
Investigating how ingesting nanoparticles may influence health
Posted: Jun 09, 2015

Taking cues from nature to develop colors that do not fade
Nanomaterial self-assembly imaged in real time
Posted: Jun 08, 2015

Researchers build world’s first fully functioning single crystal waveguide in glass
Ultrafast heat conduction can manipulate nanoscale magnets
Posted: Jun 08, 2015

Futuristic components on silicon chips, fabricated successfully
New nanocomposite material as CO2 sensor
Posted: Jun 08, 2015

Injectable nanoelectronics for treatment of neuro-degenerative diseases
Why crystals could be the shape of future pharmaceuticals
Posted: Jun 08, 2015

Nanotechnology developed by U.S. space program could find use in deep brain stimulation
Ink-free color painting with nanomaterials
Posted: Jun 08, 2015

Take a survey on risk management of nanotechnology
Stable perovskite solar cells developed through structural simplification
Posted: Jun 08, 2015

Diffusion and remote detection of hot-carriers in graphene
Moving sector walls on the nano scale
Posted: Jun 08, 2015

‘Chlorination-less’ wins nanotechnology student video contest (w/video)
Researchers design the most precise quantum thermometer to date
Posted: Jun 05, 2015

Next-generation illumination using silicon quantum dot-based white-blue LED
Stretchable nano-ceramics made by flame technology
Posted: Jun 05, 2015

Solvent encapsulation is the trick: a solid material with spin-transition solution-like behaviour
New study shows the dynamics of active swarms in alternating fields
Posted: Jun 05, 2015

The future for antiferromagnetic memories
Unlocking nanofibres’ potential: A universal transition
Vanishing friction boost development of nanomachines (w/video)
Posted: Jun 05, 2015

A coherent look at crystalline defects
A microscopic approach to the magnetic sensitivity of animals
Posted: Jun 04, 2015

New model simulates engineered nanoparticles in surface waters
Engineers show how ‘perfect’ materials begin to fail at the nanoscale
Posted: Jun 04, 2015

Cost-effective risk assessment of nanomaterials may be feasible
Visualising nanoscale changes in the electronic properties of graphene
Posted: Jun 04, 2015

Fabrication of carbon nanotube transparent conductive film with long-term stability
Water near a water-repelling surface cannot dissolve salts
Posted: Jun 04, 2015

How to cut a vortex into slices
New international prize recognizes advances in nanotechnology for medicine and biology
Posted: Jun 03, 2015

Ultra-tough fiber imitates the structure of spider silk
How natural channel proteins move in artificial membranes
Posted: Jun 03, 2015

Nano-spirals could guard against identity theft
Posted: Jun 03, 2015

...MORE NANOTECHNOLOGY RESEARCH NEWS
Injectable nanoelectronics for treatment of neuro-degenerative diseases.