Carbon Nanofiber Arrays Introduced as Artificial Local Environments into Cells

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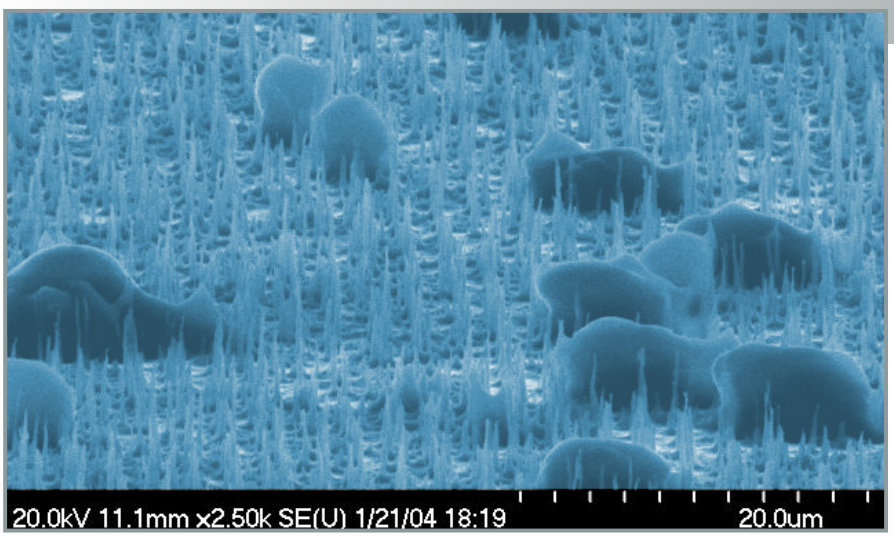

Technology Summary

To deliver materials and affect the intracellular function of a cell, ORNL researchers created an artificial local environment from carbon nanofibers. The invention allows materials to be introduced to select areas of a cell without interacting with other cellular components or regions. This advancement in nanotechnology is important for multiple applications, including biosensors, implantable tissue diagnostics, DNA and pharmaceutical delivery systems, and environmental monitoring and remediation.

Researchers grow the vertically aligned carbon nanofibers with an electrically conductive connection to an insulating surface on a substrate. They then introduce an array of these nanostructures to a biological cell. The nanofibers can be modified for specific applications by conventional organic chemistry techniques. The result is a tethered molecule that is delivered to the intracellular domain of a cell

For example, a subnuclear compartment that contains exogenous DNA may be introduced to a cell's nucleus to augment the host cell's genomic DNA and to impart additional function to the cell. The compartmentalization of this introduced material enables transcription of the DNA, but does not allow interaction with the host cell's chromosomes.

Advantages

- Delivers exogenous DNA to a cell without recombination
- Delivers enzymes, pharmaceutical materials to a cell and protects these from degradation
- Can genetically reprogram a cell by introducing a transcriptional gene or set of genes without integrating into the host cell chromosome

Potential Applications

- Patterned cathodes for and electrochemical probes
- Biosensors, implantable cell and tissue diagnostics, cell culture research platform, chemical/biochemical/electrophysiological research platform
- Delivery system for DNA, pharmaceuticals
- Macromolecular delivery system
- Parallel cellular probing, parallel cellular manipulation and modification
- Field use that requires platform tethered enzymes or DNA encoding
- To treat processes with organisms while reducing risk of organism escaping from system

Patents

Timothy E. McKnight, Anatoli V. Melechko, Guy D. Griffin, Michael A. Guillorn, Vladimir I. Merkulov, and Michael L. Simpson, *Parallel Macromolecular Delivery and Biochemical/ Electrochemical Interface to Cells Employing Nanostrucutres*, U.S. Patent Application 10/408,294, filed April 7, 2003.

Timothy E. McKnight, Anatoli V. Melechko, and Michael L. Simpson, *Method and Apparatus for Sustaining Viability of Biological Cells on a Substrate,* U.S. Patent Application 2004/0197909, filed July 4, 2003.

Michael A. Guillorn, Timothy E. McKnight, Vladimir I. Merkulov, Anatoli V. Melechko, and Michael L. Simpson, *Individually Electrically Addressable Vertically Aligned Carbon Nanofibers on Insulating Substrates,* U.S. Patent 6,982,519, issued January 3, 2006.

Michael A. Guillorn, Timothy E. McKnight, Vladimir I. Merkulov, Anatoli V. Melechko, and Michael L. Simpson, *Individually Electrically Addressable Carbon Nanofibers on Insulating Substrates,* U.S. Patent 7,144,287, issued December 5, 2006.

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