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LAB TALK

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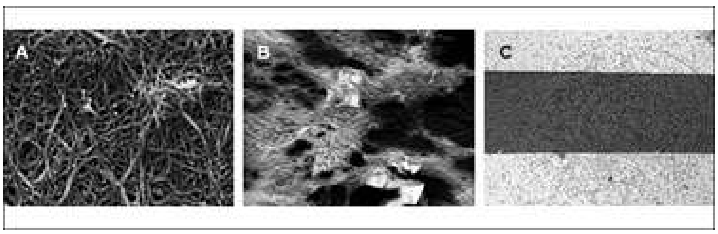
Carbon nanotube-based substrates offer multiple bioapplications

Recent studies have shown that carbon nanotube embedded substrates are biocompatible and most importantly they can support the growth of several cell types, including neurons and bone cells. There is considerable interest in the development of these materials in view of their potential use in a variety of applications that range from electronics to medicine.



(http://images.iop.org/objects/ntw/journal/9/8/12/image1.jpg)

Biocompatible: carbon nanotube embedded films (http://images.iop.org/objects/ntw/journal/9/8/12/image1.jpg)

The physical and chemical characteristics of these substrates vary depending on the methods used to synthesize and purify the nanotubes, and in the past it was not clear how these properties affected the response of the biological host. Now, a team from Rutgers University and UMDNJ Robert Wood Johnson Medical School, both in the US, has shown that it is possible to control and therefore enhance specific steps in bone cell growth by fine-tuning the attributes of the films.

The researchers used an ad hoc set-up to prepare carbon nanotube films in which the fine structure and the surface energy of the substrate (image A) could be experimentally controlled. Using a variety of techniques including electron and atomic force microscopy, the researchers found that high surface energy (hydrophilic) films yielded better attachment than low surface energy (hydrophobic) films. In both film types, however, adhesion was maximal on medium roughness surfaces and minimal on smooth surfaces (image B). In contrast, proliferation was not dependent on the surface energy and depended on the fine structure of the film with smooth surfaces yielding maximal proliferation rates.

Different design options

These results underscore a unique feature of carbon nanotube embedded films: their tremendous flexibility. This implies that these nanomaterials could be specifically designed to suit different uses. For example, hybrid devices comprising living cells that are in operative contact with an extracellular planar electrode, such as field effect transistors (image C), might be constructed using high proliferation films. In contrast, high surface energy films might be employed in situations that require good cell-to-substrate attachment, such as bone-prosthesis as well as bone-fracture healing, a problem quite common in the elderly.

More details (http://iopscience.iop.org/0957-4484/21/31/315102/) can be found in the journal

Nanotechnology.

About the author

Wojtek Tutak is a PhD student in the Materials Science and Engineering program at Rutgers University. Wojtek has a bachelor in Biomedical Engineering (NJIT) and will graduate in 2010 with a thesis entitled "Single walled carbon nanotube networks as potential bone scaffolding materials". Manish Chhowalla is a professor, Donald H Jacobs chair in applied physics at Rutgers University and director of the NSF-funded Nanotechnology for Clean Energy IGERT Program. He is also a visiting professor in the Department of Materials at Imperial College London. Dr Federico Sesti is an associate professor in the Department of Physiology and Biophysics at UMDNJ Robert Wood Johnson Medical School. Dr Sesti graduated in physics at the University of Genova, Italy, and did his postdoc at Yale University in the laboratory of Dr Steve Goldstein.