BULLETIN

October, 2010

Thursday, November 25, 2010 **_ASM Canada Council M. Brian Ives Lecture_**

The Role of Electron Microscopy in the Development of New Functional Materials

G.A. Botton, Ph.D.

Electron microscopy has played a major role in the understanding of fundamental properties of materials and the development of new materials. From the first observations of dislocations to the development of high-density memory storage used in computers hard disks today, electron microscopy has always provided insight into the structure-properties relationships and given materials scientists and engineers an invaluable tool to understand the structure of materials. The modern transmission electron microscope (TEM) provides an ever increasing resolving power and an impressive range of techniques to study structural and even bonding state information that can be used to understand the complex materials that are being developed today.

After an historical review of the evolution of electron microscopy and early applications related to the study of defects (for example dislocations and irradiation damage), this lecture will present the state-of-the-art in transmission electron microscopy and review the science of image interpretation in such modern instruments. After this review, many examples of applications of electron microscopy in the study of functional materials will be given. These examples will cover the development of new ultrahard tools used for metal cutting, fuel cell applications, the study of biomaterials interfaces with living tissues and various electronic materials used for solid-state lasers and multiferroic materials used for the next generation of higher density memory storage. The talk will emphasize the key information retrieved with detailed interpretation of the data and the new chemical and bonding information that can be deduced with the new instrumentation even down to the atomic level.

Location: Assiniboine Gordon Inn on the Park, 1975 Portage Avenue, Winnipeg
Times: Registration/Reception 6:15 p.m., Dinner 6:45 p.m., Presentation 8:00 p.m.
Cost: Members $15, Non-members $20, Students $10

RSVP: Please phone Victor Butts at 632-3985 or send him an e-mail to vbutts@rrc.mb.ca by noon Tuesday, November 23, with your name and the number of people who will be attending. Friends and colleagues are welcome. Map of the location can be found on page 4.

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Gianluigi A. Botton received a B. Eng. degree in Engineering Physics in 1987 and a PhD in Materials Engineering in 1992 at Ecole Polytechnique of Montreal, Canada. He was NSERC Postdoctoral Fellow in the Department of Materials Science and Metallurgy at the University of Cambridge from 1993 to 1995 and then Senior Research associate in the same department from 1995 to 1998. He was awarded a Junior Research Fellowship at Darwin College, Cambridge from 1996 to 1998. He joined the Materials Technology Laboratory of Natural Resources Canada (NRCan) in 1998 as a research scientist. In 2001 he joined the Department of Materials Science and Engineering at McMaster University where he was awarded a Canada Research Chair in Electron Microscopy of Nanoscale Materials in 2002. He currently leads the Canadian Centre for Electron Microscopy- a national facility for ultrahigh resolution electron microscopy at McMaster University.

Canada Council Lecture Event:

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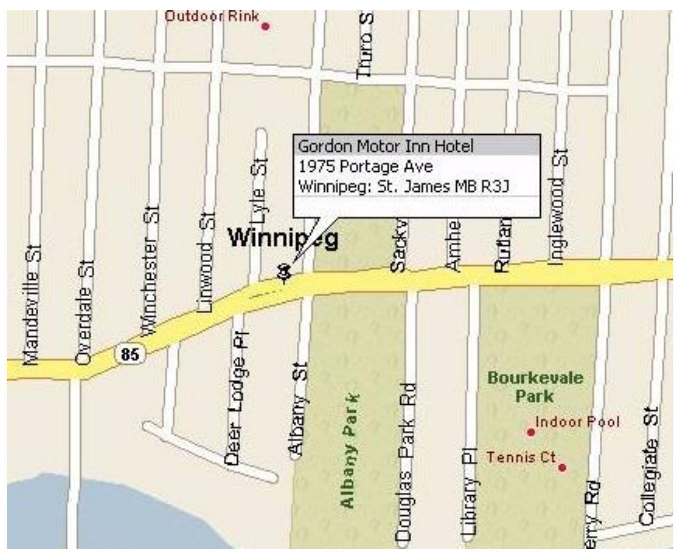
by noon, Tuesday, November 23



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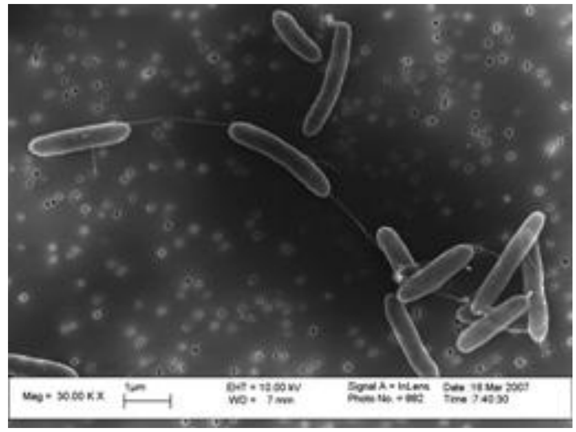

Like human hair, a baterial nanowire consists mostly of protein

Some bacteria grow electrical hair that lets them link up in big biological circuits, according to a University of Southern California biophysicist and his collaborators. The finding suggests that microbial colonies may survive, communicate and share energy in part through electrically conducting hairs known as bacterial nanowires.

"This is the first measurement of electron transport along biological nanowires produced by bacteria," said Mohamed El-Naggar, assistant professor of physics and astronomy at the USC College of Letters, Arts and Sciences.

El-Naggar was the lead author of a study appearing online next week in Proceedings of the National Academy of Sciences.

Knowing how microbial communities thrive is the first step in finding ways to destroy harmful colonies, such as biofilms on teeth. Biofilms have proven highly resistant to antibiotics.

The same knowledge could help to promote useful colonies, such as those in bacterial fuel cells under development at USC and other institutions.

"The flow of electrons in various directions is intimately tied to the metabolic status of different parts of the biofilm," El-Naggar said. "Bacterial nanowires can provide the necessary links … for the survival of a microbial circuit."

A bacterial nanowire looks like a long hair sticking out of a microbe's body. Like human hair, it consists mostly of protein.

To test the conductivity of nanowires, the researchers grew cultures of Shewanella oneidensis MR-1, a microbe previously discovered by co-author Kenneth Nealson, Wrigley Professor of Geobiology at USC College.

Shewanella tend to make nanowires in times of scarcity. By manipulating growing conditions, the researchers produced bacteria with plentiful nanowires.

The bacteria then were deposited on a surface dotted with microscopic electrodes. When a nanowire fell across two electrodes, it closed the circuit, enabling a flow of measurable current. The conductivity was similar to that of a semiconductor – modest but significant.

When the researchers cut the nanowire, the flow of current stopped.

Previous studies showed that electrons could move across a nanowire, which did not prove that nanowires conducted electrons along their length.

El-Naggar's group is the first to carry out this technically difficult but more telling experiment.

Electricity carried on nanowires may be a lifeline. Bacteria respire by losing electrons to an acceptor – for Shewanella, a metal such as iron. (Breathing is a special case: Humans respire by giving up electrons to oxygen, one of the most powerful electron acceptors.)

Nealson said of Shewanella: "If you don't give it an electron acceptor, it dies. It dies pretty rapidly."

In some cases, a nanowire may be a microbe's only means of dumping electrons.

When an electron acceptor is scarce nearby, nanowires may help bacteria to support each other and extend their collective reach to distant sources.

The researchers noted that Shewanella attach to electron acceptors as well as to each other, forming a colony in which every member should be able to respire through a chain of nanowires.

"This would be basically a community response to transfer electrons," El-Naggar explained. "It would be a form of cooperative breathing."

El-Naggar and his team are among the pioneers in a young discipline. The term "bacterial nanowire" was coined in 2006. Fewer than 10 studies on the subject have been published, according to co-author Yuri Gorby of The J. Craig Venter Institute in San Diego, discoverer of nanowires in Shewanella.

Gorby and others became interested in nanowires when they noticed that reduction of metals appeared to be occurring around the filaments. Since reduction requires the transfer of electrons to a metal, the researchers suspected that the filaments were carrying a current.

Nanowires also have been proposed as conductive pathways in several diverse microbes.

"The current hypothesis is that bacterial nanowires are in fact widespread in the microbial world," El-Naggar said.

Some have suggested that nanowires may help bacteria to communicate as well as to respire.

Bacterial colonies are known to share information through the slow diffusion of signaling molecules. Nealson argued that electron transport over nanowires would be faster and preferable for bacteria.

"You want the telegraph, you don't want smoke signals," he said.

Bacteria's communal strategy for survival may hold lessons for higher life forms.

In an op-ed published in Wired in 2009, Gorby wrote: "Understanding the strategies for efficient energy distribution and communication in the oldest organisms on the planet may serve as useful analogies of sustainability within our own species."

In addition to El-Naggar, Gorby and Nealson, the study's authors were Thomas Yuzvinsky of USC College; Greg Wanger of The J. Craig Venter Institute; and Kar Man Leung, Gordon Southam, Jun Yang and Woon Ming Lau from the University of Western Ontario.

Funding for the research came from the Air Force Office of Scientific Research, the U.S. Department of Energy, the Legler-Benbough Foundation, the J. Craig Venter Institute, the Canadian Natural Science and Engineering Research Council, the Canada Foundation for Innovation and Surface Science Western.

More information: University of Southern California

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