217th ECS Meeting

VANCOUVER

Home of the 2010 Olympic Winter Games

meeting highlights

Although the traffic and the crowds from the 2010 Olympic & Paralympic Winter Games were long gone, Vancouver was an exciting venue for the 217th ECS Meeting. This was the first time the Society held a meeting in this city of over 500,000 people. While the Capilano Suspension Bridge, Stanley Park, Grouse Mountain, and other sites provided plenty of outdoor adventures for attendees, the indoor adventures were equally compelling. Well over 1,800 attendees were able to choose from 1,849 papers in 42 sessions. Students were a big part of the meeting, and six students received Student Poster Session awards for their excellent papers at the Annual Business Meeting of the Society (see page 60). At the Annual Business Meeting, President Paul Natishan reported that ECS had a remarkable year in 2009, including (among other notable achievements) a 15% increase in the number of submissions to the technical journals; and the ever-broadening sponsorship of conferences around the world, including CSTIC, held in China in March (see page 16). The IE&EE Division held another successful Outreach program during the meeting week, this time at the Britannia Secondary School in Vancouver (see page 12). Good energy was felt by the meeting attendees and all kinds of energy were clearly a large part of the technical program at the meeting, including the keynote lectures of the plenary session and from the de Nora Award winner.

The Future of Energy Conversion

The ECS Lecture, "The Future of Energy Conversion: A Perspective from the Chemical Industry" was given by **William (Bill) F. Banholzer** on Monday evening. The packed audience was testimony that the experiment of moving the plenary talk to the evening (instead of on Monday mornings as had been the tradition) was a successful one. The speaker was introduced by ECS President Paul Natishan. Dr. Banholzer is Excecutive Vice-President for Ventures, New Business Development, and Licensing, and the Chief Technology Officer of the Dow Chemical Company. He is responsible for driving innovation, value creation, and Dow's R&D activities globally. Dr. Banholzer joined Dow in 2005 after a stellar career with General Electric Co. He received his master's and doctoral degrees in chemical engineering from the University of Illinois. Other details of his career accomplishments may be found in the spring 2010 issue of *Interface* (Vol. 14, p. 14).

Dr. Banholzer began his talk by noting the long history between The Dow Company and ECS that began when the company founder, Herbert Dow, invented the zinc-bromine storage battery 108 years ago. He also noted the tidbit that the choice of Midland, Michigan for the company headquarters was rooted in the national availability of raw material resources in the region. The chemical industry perspective on fuels is naturally hinged on fossil fuels being an important chemical feedstock. Energy R&D and the chemical industry share a common interest in moving electrons and chemical bonds. These activities are not new and neither are devices such as solar cells and fuel cells. So why has the time come for these

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technologies to mature and why didn't that happen before? This formed the essence of Dr. Banholzer's message, which for one, was that thermodynamic considerations should never be forgotten in the initial assessment of a technology. The magnitude of the energy problem was then underlined with the chemical industry itself using 10,500 TWh that roughly translates to 8% of world consumption.

Dr. Banholzer focused on four energy areas: biofuels, photovoltaics, fuel cells, and batteries. In each case, he addressed aspects related to material and energy balance, cost, sustainability, and control volume. At the outset he pointed out value chain arguments in progressing from methane to a polymer such as polyethylene and showed corresponding graphics driving this message with plots for coal, crude oil, refined gasoline, biomass, corn, and ethanol product progressions. Capital intensity was compared for gas/oil, coal, nuclear, wind, biomass conversion, and IGCC plants. Banholzer's assessment of biomass was pessimistic because of issues related to scalability, low photosynthesis efficiency, land area requirements, etc. Capital costs for biomass are extreme and the prohibitive cost coupled with the need for water would conspire against massive deployment of this energy technology. Interestingly, he pointed out that, in his opinion, the successful Brazil model based on sugarcane "gasohol" was a one-off case predicated on a closed market.

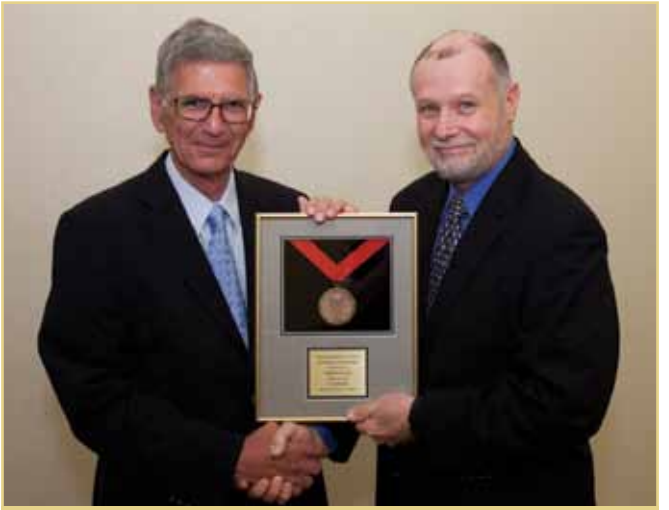
The speaker then turned his attention to the solar energy resource, pointing out that immense amounts of this energy are incident on the earth's surface although intermittency and cost are outstanding issues. He discussed Dow's activities in the solar energy conversion area and showed a video clip of technicians installing the Dow Powerhouse™ shingle. He projected a product cost of $2-3 per sq. ft. with a $8.25/W unit cost, with a typical panel providing 10 W/sq.ft. Dow also has a presence in heat transfer fluid formulations and Dow Corning manufactures Si wafers. Dr. Banholzer turned to the hydrogen economy and cost projections for a H_2 powered vehicle derived from electrolytically-produced gas. His conclusion, and one that he pointed out could well be controversial to the ECS community, was that fuel cells were not an economically viable option for large-scale transportation deployment.

The last part of this fast-moving talk was devoted to batteries and energy storage. He noted that Dow was active in battery cathode, anode, and electrolyte separator components. He pointed out the need for new approaches to energy storage for applications related to the smart grid. Departing from the usual protocol with plenary talks, the speaker did solicit questions from the audience, of which there were quite a few.

Energy Storage for Renewable Generation

The Vittorio de Nora Award lecture entitled, "Toward Energy Storage for Renewable Generation" was given by **Derek Pletcher** on Monday morning. Prof. Pletcher was introduced by a former student and currently the President/CEO of Electrosynthesis, David Genders. Prof. Pletcher was elected an ECS Fellow in 2005 and received the ECS Henry B. Linford Distinguished Teaching Award in 2006. Many in ECS have benefitted from his classic textbook, *Industrial Electrochemistry*. Prof. Pletcher's many other accomplishments are outlined in the spring 2010 issue of *Interface* (Vol. 19, p. 14).

The speaker first outlined the current need for a sustainable, long term supply of energy and pointed out how electrochemical technology can contribute in several ways to energy storage in such an economy. He listed the requirements of a storage technology candidate and showed the extent to which approaches based on water electrolysis or batteries met these criteria. His talk subsequently focused on the flow battery approach. He mentioned first the electrical storage facility built by Regenesys Technologies Ltd. at



Derek Pletcher *(left) was the recipient of the 2010 ECS Vittorio de Nora Award. One of the Society's most prestigious award, it is given for contributions to the field of electrochemical engineering and technology. The award was presented at the meeting in Vancouver by ECS President* **Paul Natishan** *(right).*

"The Future of Energy Conversion: A Perspective from the Chemical Industry" was the topic of The ECS Lecture, given by **William Banholzer** *(left) at the plenary session of the ECS meeting in Vancouver. With Dr. Banholzer is ECS President* **Paul Natishan**.

The ECS Henry B. Linford Award for Distinguished Teaching is given to recognize excellence in teaching in subject areas of interest to the Society. The 2010 award was presented to **Daniel Schwartz** *(left) by ECS President* **Paul Natishan**.

Ashish Shah *(left) and* **Randy Leising** *(center), both of Greatbatch, Inc. were on hand at the ECS meeting in Vancouver to receive a Leadership Circle Award from ECS President* **Paul Natishan** *(right). Greatbatch (www.greatbatch.com) has been a Corporate Member of ECS since 1985 and received a Gold Level award for their 25 years of membership.*

Ralph Brodd *(left), of Broddarp of Nevada (www.broddarp.com), received a Silver Level Leadership Circle Award, for 10 years of Corporate Membership. Dr. Brodd, a past President of ECS (1981-1982), received his award from* **Paul Natishan**, *the 2009-2010 ECS President.*

Frank Dalton *(left), of Pine Research Instrumentation (www.pineinst.com/echem), received a Bronze Level Leadership Circle Award from ECS President* **Paul Natishan**, *for five years of Corporate Membership.*

the Lille Barford Power Station in Bedfordhire, U.K. This was a 10 MW/50 MWh plant comprised of 200 cells and the demonstration system showed high cycle life with no membrane leakage issues on long-term operation.

Prof. Pletcher turned to a brief review of redox flow batteries and introduced his current work on a soluble lead acid flow battery. This battery is similar to the one used in automobiles with the exception that high Pb(II) solubility is ensured by the use of methane sulfonic acid as the electrolyte in the negative electrode compartment. The deposit on the positive electrode is the alpha phase of PbO_2. Charge-discharge data were shown for a 10 cm x 10 cm flow cell. The overall energy efficiency of this system approaches 60-70% and it can achieve 30-5-deep charge/discharge cycles under a range of conditions. Current bottleneck issues were addressed including electrode shorting and dendrite/powder formation on the negative electrode where Pb accumulates. Possible solutions to these problems include the periodic addition of hydrogen peroxide to the electrolyte (which regenerates Pb(II) species from Pb and PbO_2) or tuning of the PbO_2 layer morphology to improve acid ingress.

Prof. Pletcher closed his talk with perspectives for future work in this area and noted the need for a collective approach from the community for attacking outstanding technology issues in energy storage. His subliminal message was for the scientists and engineers to engage in open discussions without barriers from intellectual property protection concerns. He finally thanked his colleagues in Southampton (Martin Fleischmann and Phil Bartlett) and in Electrosynthesis Company (Norm Weinberg) and, last but not least, his wife, Gill.

Carbon Nanotubes for the Rest of Us...

The ECS "XYZ for the Rest of Us" talk series helps to educate the meeting attendees about technical areas outside of their immediate domain. A secondary objective is to foster cross-disciplinary interactions. The particular lecture in this series in Vancouver was entitled "Carbon Nanotubes and Graphene: Prospects in Electronics and Photonics" and was given by **Phaedon Avouris** of IBM, T. J. Watson Research Center in Yorktown Heights, NY. The speaker was introduced by his IBM colleague and ECS Education Committee Chair, Lili Deligianni to a packed audience on Sunday evening. Dr. Avouris is an IBM Fellow and his many accomplishments in the carbon nanotube (CNT) and graphene area are outlined in the spring 2010 issue of *Interface* (Vol. 19, p. 15). Within ECS, he is particularly well-known to members of the Fullerenes, Nanotubes, and Carbon Nanostructures Division where he won the Richard E. Smalley Research Award.

Dr. Avouris began his talk with a very clear exposition of the structural and chemical features of CNTs and graphene. He also noted the historical origins of these materials and noted the relationship of graphite and graphene. The unique structure and low dimensionality of CNTs and graphene open up a host of applications in electronics and photonics that formed the theme of this tutorial lecture. After a few introductory slides, Dr. Avouris turned to the band structure of graphene and noted the exceptionally high carrier mobility that could be secured in this material because of its rather unique band structure. The performance metrics were compared with those from a prototype microelectronics material, silicon.

After a discussion on the preparative aspects of these advanced materials, the last part of the lecture focused on applications related to ultra-fast transistors, infrared light emitters, and simple integrated circuits. Both the positive features of devices based on CNTs and graphene, as well as the hurdles that remain, were enumerated in a very balanced perspective that was much appreciated by the attentive audience.

IE&EE Division Outreach Program in Vancouver

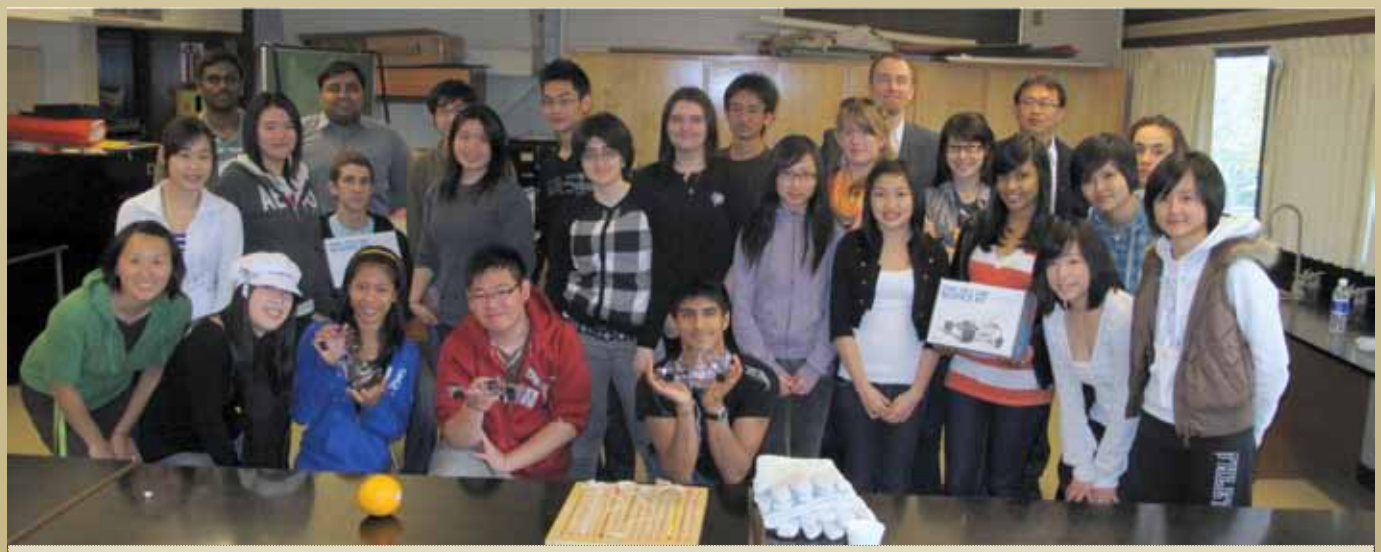
by Vijay Ramani

The IE&EE Division continued its Outreach Program at the 217th ECS meeting in Vancouver in April 2010. The program demonstrated the tenets of a renewable and sustainable energy economy and the role of electrochemistry and electrochemical engineering in such a scenario. This event marked the 8th consecutive time that volunteers from the IE&EE Division visited a local high school in the ECS meeting city to conduct this outreach program (see page 40 for an article on how others can replicate this program). The first seven programs were conducted in Cancun, Chicago, Washington, DC, Phoenix, Honolulu, Oakland, and Vienna and over 400 middle and high school students have benefitted from this program to date.

Twenty-six students in the 11th grade at the **Britannia Secondary School** in the inner city of Vancouver, led by their teacher **Yulanda Yuen**, participated in this program. The class was sub-divided into five teams of students, each of which participated in the traditional electrolyzer/fuel cell car activity. In this activity, teams had to produce sufficient hydrogen and oxygen (through electrolysis, based on data from prior calibration experiments) to propel their fuel cell car a pre-determined distance. The winning team came within 6 inches of the target distance set by the organizers. The winning team members were: **Zak Suleman**, **Megan Mulder**, **Jacky Chen**, **Delaram Arabi**, and **Sorina Moldovan**. ECS and the IE&EE Division congratulate them on their accomplishment. We also congratulate and thank all the students for their enthusiastic participation in the program.

The following people contributed to the organization of the outreach program. From the IE&EE Division were **Dennie T. Mah** (DuPont), **Vijay Ramani** (Illinois Institute of Technology, Chicago), **Gerardine Botte** (Ohio University), and **Venkat Subramanian** (Washington University in St. Louis). Students affiliated with the IE&EE Division included **Satheesh Sambandam** (Illinois Institute of Technology), **Venkatsailanathan Ramadesikan** (Washington University), and **Seung-Wham Lee** (Case Western Reserve University). Locally, in Vancouver, the following people assisted. **Lars Rose** (National Research Council Canada Institute for Fuel Cell Innovation, University of British

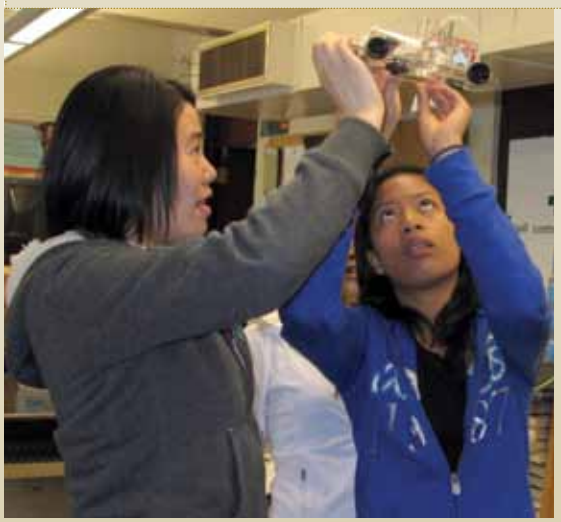
The **IE&EE Outreach Program** *held another successful event at the Britannia Secondary School. Shown here is the winning team, with some of the facilitators and 11th grade teacher Yulanda Yuen.*



The entire group of participants in Vancouver pose with the fuel cell car kits.

Scenes from the IE&EE Division's Fuel Cell Car Competition in Vancouver

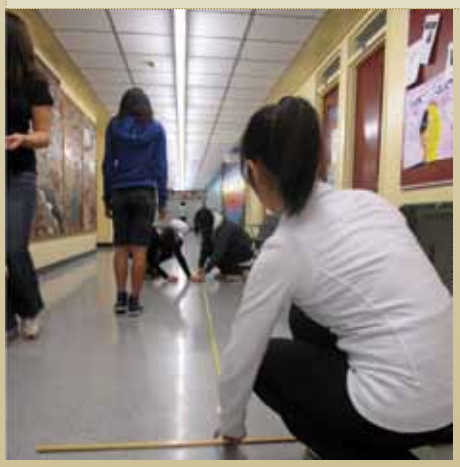
The students enjoyed some in-depth testing of the fuel cell car…



Columbia Department of Materials Engineering and Faculty of Applied Science, and the UBC Let's Talk Science Partnership Program), and Yulanda Yuen (Britannia Secondary School). The IE&EE Division and ECS thank these facilitators for their time and effort.

The Outreach Program was financially supported by Vijay Ramani's NSF CAREER award, which funded the purchase of the small-scale fuel cell cars used to conduct the program, and will continue to do so for the next four years. As is customary, the cars used were donated to Britannia Secondary School to ensure that they could conduct similar activities in the future. They have already enjoyed heavy use in the Britannia Environmental Club, and in several science fair projects. The IE&EE Division looks forward with anticipation to continuing this high-impact program at future meetings, starting with the 218th meeting in Las Vegas this autumn.

Measurements in the corridors…



One of the four races…

Last minute adjustments to the car…