219th ECS Meeting and SOFC XII

Highlights from the Montréal Meeting

From the Tutorials in Nanotechnology to the 12th iteration of Solid Oxide Fuel Cells (SOFC XII), and from the 19th "XYZ for the Rest of US" talk to the "meet and greet" event with the editor of the latest ECS monograph, over 2100 attendees of the 219th ECS Meeting in Montréal had a wealth of technical programming from which to choose.

ECS Corporate Members, currently 78 in number, partner with the Society in helping to further electrochemical and solid-state sciences. Five ECS Corporate Members were recipients of the Leadership Circle Award during the Plenary session at the ECS meeting in Montréal, Canada on May 2, 2011. The awardees includewd: **Olin Corporation, Chlor Alkali Products Division** for 70 years of continuous service (Legacy level);**TIMCAL Graphite and Carbon Ltd.**, for 25 years of continuous support (Gold level); and **Hydro Québec**, **Nissan Motor Co., Ltd.**, and **Sanyo Electric Co., Ltd.**, for five years of continuous support (Bronze level). ECS would like to thank these Corporate Members for their many years of service and support.

R. Winston Revie, Editor of *Uhlig's Corrosion Handbook*, was on hand to speak with attendees about the latest edition (3rd) of this authoritative guide on corrosion. Two lucky attendees won copies of the book, autographed by Dr. Revie, and generously donated by Wiley-Blackwell. This "meet and greet" was an excellent addition to Monday evening's packed program: Monday Evening Mixer, opening of the Technical Exhibit, and the Society's popular Student Poster Session (see page 61 for the award winners from this session).

How Can One Tell If a Li-Ion Battery Will Last for Decades in Only Three Weeks of Testing?

ECS President William D. (Bill) Brown introduced **Jeffery Dahn** of Dalhousie University, Halifax, Nova Scotia, Canada, who delivered The ECS Lecture, with the above intriguing title, to a packed Monday evening audience. The speaker is recognized as a leading contributor to the lithium-ion battery technology that is now used worldwide in laptop computers and cell-phones. Renewed interest in this technology stems from its targeted applications in electric vehicles (EVs) and grid energy storage. After stints at the National Research Council of Canada and Moli Energy Ltd, Dahn took up a faculty position in physics at Simon Fraser University in 1990. He returned in 1996 to the institution (Dalhousie University) from which he obtained his BSc in Physics, and now holds the NSERC/3M Canada Industrial Research Chair in Materials for Advanced Batteries. He has won numerous awards including the ECS Battery Division Research Award (1996) and was elected Fellow of the Royal Society of Canada in 2001.

For EV and grid energy storage applications, the batteries have lifetimes of at least 10 years (3,600 cycles) and 30 years (10,000 cycles) respectively. The battery researchers are faced with a daunting task that the speaker addressed in his lecture: How to gauge in a reasonable timeframe (*i.e.*, a few weeks) whether the already excellent Li-ion chemistry/electrochemistry will be sufficiently robust, bearing in mind that the loss in capacity for such cells is extremely small over a weeks-long window. Three types of Li-ion cells were discussed by Dahn: $LiMn_2O_4$, $LiFePO_4$, and $LiCoO_2$, all used in conjunction with graphite. These batteries are used in Chevy Volt, Toyota Prius, and Tesla roadster respectively.

Dr. Dahn set up the problem at the outset and underlined the fact that the rate at which cycling tests are done on Li-ion batteries is a crucial variable. He mentioned that many battery manufacturers choose to quote only cycling performance at high rates under which the cells may appear to be misleadingly robust. Low-rate cycles and time are key parameters, and as the test temperature is raised, things get progressively worse. This is because the rates of deleterious parasitic chemical

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Stephen Pearton *(right) was the recipient of the Gordon E. Moore Medal for Outstanding Achievement in Solid State Science and Technology. Dr. Pearton received the Medal from ECS President* **Bill Brown** *(left).*

Jeff Dahn *(left), delivered The ECS Lecture entitled, "How Can One Tell If a Li-Ion Battery Will Last for Decades in Only Three Weeks of Testing?" Prof. Dahn received a scroll recognizing his contribution from ECS President* **Bill Brown** *(right).*

reactions are temperature-dependent. The discussion then logically turned to the question of why Li-ion batteries fail. Parasitic reactions consume Li (which is irretrievably lost from the cell electrochemistry) via the formation of porous films at the electrode/electrolyte interphase and these often involve electrolyte additives as well. Other "bad" things that happen include electrolyte oxidation, transition metal dissolution, and the occlusion of (adventitious) trace water leading to HF formation. Dahn noted that advanced diagnostics are needed to probe these deleterious effects, and importantly, equipment that is badly needed is not commercially available at present. [Editor's Note: This may be a debatable claim amongst the Li-ion battery R&D community.]

In the last portion of this very fast-moving and informative lecture, Dr. Dahn reviewed data on coulombic efficiency. He advocated measurements of differential capacity *vs.* potential as an excellent monitor of battery health. One of his major conclusions was that as the technology and Li-ion cells became better, more precise diagnostic equipment would be needed in the future.

Award Lecture for the Gordon E. Moore Medal for Outstanding Achievement in Solid State Science and Technology

This award lecture, entitled: "Wide Bandgap Semiconductors for Electronics, Photonics, and Sensing Applications" was given by **Stephen Pearton** on Monday afternoon. Prof. Pearton is a leading figure in blue/green/UV GaN-based LEDs, laser diodes, and power electronics. After obtaining his PhD from the University of Tasmania and completing his post-doctoral training at UC Berkeley, Dr. Pearton joined AT&T Bell Labs. There he developed ion implantation, dry etching, and contact technologies for successive generations of compound semiconductor devices. He joined the faculty ranks of the University of Florida in 1994 where he is currently Distinguished Professor and Alumni Chair in the Department of Materials Science and Engineering.

Dr. Pearton's publications have been cited over 35,000 times in the literature and his research has garnered many awards. Among the numerous honors may be mentioned the 2005 ECS Electronics Division Award and the 2011 Bardeen Award from TMS. He is a Fellow of ECS, MRS, TMS, IEEE, and APS.

After being introduced to the audience by ECS President Bill Brown, Dr. Pearton began his award lecture acknowledging his collaborator and nominator, Fan Ren. The lecture focused on the development of GaN-based transistors for gas and bio-sensing applications. The hydrogen economy, if widely deployed, would call for wireless/remote monitoring of leaks from storage facilities and distribution pipelines. Gateless AlGaN/GaN transistor-based sensors can be used for this purposes wherein the active sensing element uses a catalyst noble metal such as Pt or Pd. The sensing mechanism is based on adsorbed (absorbed hydrogen) at these sensing sites, which then lowers the barrier height in the transistor device. In general, the sensing element can be coated with selective agents for the gaseous and ionic solution analytes including oxides, polymers, and nitrides.

Dr. Pearton then turned to the important area of biosensors. He noted that current state-of-the-art sensing alternatives (such as HPLC or ELISA) were rather slow and not easily portable. The use of semiconductor-based solid-state devices naturally lends to "field-able" and remotely-accessible sensors. He gave examples of recent work from his group in this area for sensitive

Still writing… an editor's work is never done. **R. Winston Revie** *autographed copies of his new book at the ECS meeting in Montréal, to celebrate the publication of the third edition of the classic monograph,* Uhlig's Corrosion Handbook.

The **Annual Society Luncheon and Business Meeting** *takes place at the Society's spring meeting. The business meeting is where members can learn about the most current business of the Society, and meet the winners of the Student Poster Session. At the lectern is ECS President* **Bill Brown**.

David Cawlfield *(left), of* ***Olin Corporation – Chlor Alkali Products Division****, received a Legacy Level Leadership Circle Award from ECS President* **Bill Brown** *(right). The company was one of ECS's first Corporate Members, over 70 years ago.*

and selective detection of glucose, lactic acid, prostrate cancer, and breast cancer markers. Analytes of relevance to bioterrorist threats were also presented as were environmental pollutants. An interesting family of sensors based on exhaled breath condensates, which contain many biomarkers, was discussed. Glucose, pH, and chloride ion sensors based on the use of ZnO nanorods atop the AlGaN/GaN platform were in development and nearing field trials.

The concluding part of this talk focused on thin film transistors (TFTs), on flexible substrates including paper and polyimide tape. These new-generation devices are based on indium gallium zinc oxide (IGZO) transparent conducting oxide. This active material (an *n*-type semiconductor) is gaining much attention because of its high electron mobility. The talk concluded with examples of progress and remaining roadblocks to the use of IGZO-based TFTs.

For the Rest of Us... Semiconductor Nanowires: A Platform for Nanoscience and Nanotechnology

This latest edition of the popular "XYZ for the Rest of Us" lectures on Sunday evening was presented by Prof. **Charles Lieber** of Harvard University. This talk focused on the interface between nanoelectronics and life sciences involving sensors for disease detection and the neuroscience at both single cell and whole organism levels. Nanowire-based devices were described for multiplexed recording of signals with high spatial and temporal resolution; 3D probes, and probe arrays enabled these advances. Bottom-up approaches including the daunting task of building electrical contacts to nanobio interfaces out-of-plane were presented. Many of these new families of 3D nanoprobes were targeted as substitutes for the current state-of-the-art patch-clamp strategies. In the latter part of this tutorial talk, the development of novel biomaterials that seamlessly integrate nanoelectronic device arrays with synthetic tissue was described. One underlying theme of this talk was that the use of nanowire-based electronics and devices served to blur the distinction between man-made and living systems.

Meeting Highlights was prepared by Krishnan Rajeshwar and Mary Yess, Interface's *Editor and Managing Editor respectively. All photographs from the Montréal meeting are by NH Photographes Ltée.*

Karim Zaghib *(right), of* ***Hydro Québec****, received a Bronze Level Leadership Circle Award presented to the company for five years of Corporate membership from ECS President* **Bill Brown** *(left).*

Jean L'Heureux *(left), of* ***TIMCAL Graphite and Carbon Limited****, received a Gold Level Leadership Circle Award presented to the company for 25 years of Corporate Membership from ECS President* **Bill Brown** *(right).*

Robert Haddon *(third from left) received the Fullerenes, Nanotubes, and Carbon Nanostructures Division* ***Richard E. Smalley Research Award*** *at the Montréal meeting. With Dr. Haddon are:* **Jean-François Nierengarten** *(far left), Division Secretary;* **Dirk Guldi** *(second from left), Division Chair; and* **R. Bruce Weisman** *(far right), Division Vice-Chair.*