Highlights from Chicago

Attendees of the 211th ECS meeting were treated to an array of celebrities during the week. In addition to the two stellar speakers at the Plenary Session on Monday morning, attendees also caught glimpses of U.S. Presidential candidates Barack Obama and Hilary Clinton; and celebrities Oprah Winfrey and the Mayor of Chicago. In addition to the fun, the over-1,500 attendees presented 1,355 papers in 38 sessions. An innovation of the meeting was the presentation of the Student Poster Session Awards at the Annual Society Luncheon and Business Meeting on Tuesday. Twenty-four booths in the Technical Exhibit provided attendees with a wealth of information on services, hardware, and software related to the needs of those in the fields ECS serves. This meeting also heralded a change in format: on Monday morning there was a newly-combined Plenary Session and Honors and Awards session. Thus the audience was treated to a "two-for-one" in Chicago in terms of featured talks.

Plenary Session

The ECS Lecture was given by **James Tour** of Rice University and his talk was entitled, "Nanocars and Hybrid Silicon/Molecule Devices." Prof. Tour is currently the Chao Professor of Chemistry, Professor of Computer Science, and Professor of Mechanical Engineering and

Nanovehicles were the subject of the ECS Lecture at the Plenary Session in Chicago this past spring. **James M. Tour** *(second from left) delivered a fascinating talk on molecular machines. Joining him before the talk were ECS Vice-President* **D. Noel Buckley** *(far left), ECS President* **Mark Allendorf** *(third from left), and ECS Executive Director* **Roque Calvo** *(far right).*

Materials Science at Rice. He is also Director of Rice University's Carbon Nanotechnology Laboratory in the Smalley Institute for Nanoscale Science and Technology.

Dr. Tour began his lecture by pointing out that a key roadblock in molecular electronics was the difficulty in making good metal/molecule contacts. A way around this would be to eliminate this interface altogether and instead graft molecules directly on the Si surface in a "moleFET" configuration. Thus the current in this type of device would be driven through the Si base rather than through the molecules themselves. He then showed data on turn-on voltages in the transistor as a function of the molecular architecture. Three-terminal field effect transistors (FETs) using intrinsic Si nanowires were also discussed. Forming an F-terminated silicon oxide surface significantly decreased the resistivity and increased the mobility, enabling its use in memory devices.

The lecture then turned to the topic of molecular motors and nanocars. A key application here would be the transport of targeted chemicals along surfaces much like the body does naturally via "biochemical and biophysical machines." Prof. Tour began this topic by contrasting the traditional "top-down" synthetic paradigm with a "bottom-up" molecular approach. Particularly striking was the analogy made in the top-down construction of a lectern which is fashioned from wood out of a tree. The lecture then focused on examples drawn from video demonstrations of a nanoCaterpillar, a nanoCooper, dipolar nanocar, nanotruck, nanoworm, nanobackhoe, and a nanotrain. Many of these fascinating nanoarchitectures exemplified synthetic motifs based on molecular self-assembly, metal complexation and hydrogen bonding.

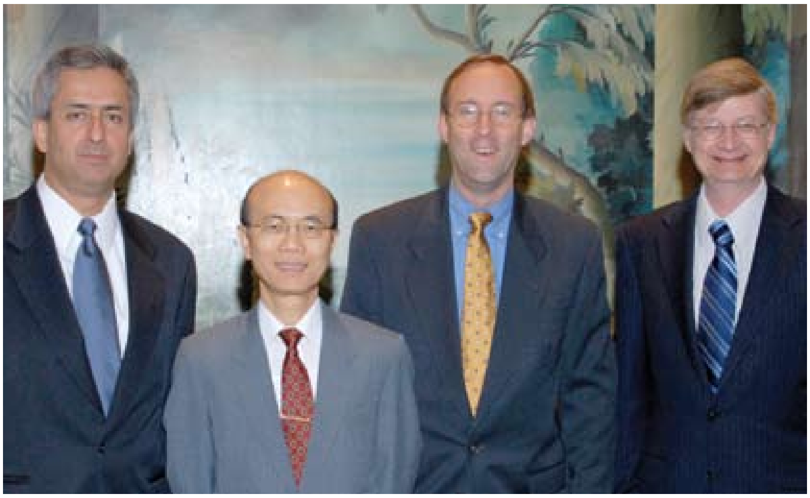
Prof. Tour concluded his entertaining and fast-moving talk by noting that the hardest part of the nanocar project was not the synthesis but learning how to manipulate and move objects on a nanometer size scale. The needed tools such as scanning probe microscopies, in his opinion, are lagging behind the synthetic advances. For the nanotransporter concept to become practical, our ability to reproducibly observe and move nanometric objects will have to improve significantly along with continuing advances in our understanding of defects and molecule-surface interactions on surfaces such as Au (111) and Si (100).

Gordon E. Moore Medal Award Lecture

The second lecture on Monday morning was given by **Tak H. Ning** of IBM, the first recipient of the Gordon E. Moore Medal for Outstanding Achievement in Solid State Science and Technology (see *Interface*, Vol. 16, No. 1, p. 11, for a story on this re-named award). Dr. Ning joined IBM at the T. J. Watson Research Center in 1973 and is currently an IBM Fellow. His award talk was entitled, "Thirty Years of Fun and Excitement Working on Silicon Technology at IBM Research."

After the medal award by Dr. Mike Mayberry of Intel Corp., Dr. Tak Ning was introduced in glowing and affectionate terms by his IBM colleague, Dr. Ghavam Shahidi. The awardee first thanked his family, then Hwa N. Yu (his mentor at IBM), and finally his colleagues at IBM. He began his lecture by outlining the contributions, in the late '70s and '80s, of his R&D team to the understanding of hot electron effects and electron/hole trapping in MOSFETs. They then turned to the shallow emitter effect and its dependence on emitter-contact material. This led to the development of the poly Si emitter self-aligned bipolar transistor (termed by Dr. Ning as a serendipitous discovery). Bipolar junction transistors, or BJTs, formed the backbone of the

(continued on next page)



The first Gordon E. Moore Medal for Outstanding Achievement in Solid State Science and Technology was presented to **Tak H. Ning** *(second from left), who delivered a talk on his 30 years at IBM.* **Mike Mayberry** *(far right), Vice-President of the Technology/Manufacturing Group, and Director of Components Research, represented Intel, which endowed the newly-renamed Moore Medal.* **Ghavam Shahidi** *(far left), from IBM Corporation, introduced Dr. Ning. ECS President* **Mark Allendorf** *(third from left) presented Dr. Ning with the new Moore Medal.*

Professor **Allen J. Bard** *(left) received the 2007 Gerischer Award Recipient of the ECS European Section from ECS President* **Mark Allendorf**. *Prof. Bard has been the Hackerman-Welch Regents Chair in Chemistry at the University of Texas since 1985 and is renowned in the field, including being recognized for helping to develop scanning electrochemistry microscopy.*

ECS President **Mark Allendorf** *(right) presented Leadership Circle Awards to long-time corporate supporters of ECS.* **Dayal Meshri** *(left) received a Silver Level Award on behalf of Advance Research Chemicals and* **Frank McGorty** *(center) received a Gold Level on behalf of Gruppo De Nora. Missing from the photo was* **Dan Scherson***, who received a Silver Level Award on behalf of the Ernest B. Yeager Center for Electrochemical Sciences at Case Western Reserve University. Unable to attend the meeting were CSIRO Minerals at Gold Level and Permascand AB at the Bronze Level.*

IBM mainframe computers until the advent of low-voltage CMOS technology in the late 1990s. In the 1970s and '80s, Dr. Ning's team also invented the substrate-plate trench-capacitor DRAM cell, which is widely used in stand-alone and embedded DRAM products (e.g., the BlueGene supercomputer). In the intervening period from 1982 until 1991, he directed and contributed to the development of submicron bipolar and CMOS technologies as well as led his team in exploring Si-on-insulator (SOI) devices.

The final part of this lecture focused on the limits of CMOS and exploring opportunities in the silicon technology space beyond CMOS scaling. Dr. Ning indicated that the figure-of-merit may no longer be just the processor speed but will also include the number of cores and the memory capacity along with bandwidth. He underlined the critical need to remove the "memory bottleneck" by invoking the SOI and system-on-a chip technology solutions—themes that are further elaborated in a preceding issue of this magazine (*Interface*, Vol. 16, No. 1, p. 11).

"XYZ for the Rest of Us" Lecture

The latest edition of this popular Sunday evening lecture series was entitled, "Transistor Lasers: Opening New Optoelectronic Frontiers," by Milton Feng, the Nick Holonyak, Jr. Chair Professor of Computer and Electrical Engineering at the University of Illinois, Urbana-Champaign. The topic of this lecture was featured in one of the top five papers in the 43-year history of *Applied Physics Letters* (Vol. 84, p. 151, 2004). Transistor lasers were also anointed as one of the top 100 most important discoveries in 2005 by *Discover* magazine). The possibility of using light to replace (or augment) electrical charge for data processing applications has been hitherto hampered by the low modulation speed inherent in the nanosecond electron-hole recombination lifetimes in diode lasers. While developers of heterojunction bipolar transistors (HBTs) had long been aware that current flow through the base must generate some light,

Attendees enjoying a coffee break after the Plenary Session on Monday.

A view of the Technical Exhibit at the 212th meeting.

the conventional wisdom was this was a bad thing to have from a device perspective. Dr. Feng and his collaborators (Holonyak and Hafez) realized that the data processing application bottleneck could be removed by coupling the picosecond speed of HBTs with lasing action.

An historical foray into the discoveries (that led to several Nobel Prizes) then followed of the transfer resistor or the transistor, integrated circuits or ICs, and semiconductor heterojunctions. The importance of the discovery of light emitting diode or LED and diode laser by Robert Hall (who observed emission in the IR wavelength range) and Nick Holonyak, Jr. (who reported visible light emission) underpinned the subsequent development of the transistor laser. Feng and collaborators then made exciting observation of light emission from InGaP/GaAs BPTs after some hiccups associated with the wrong choice of detectors. He concluded the lecture by pointing out many of the positive features of transistor lasers, relative to diode lasers, including a wider dynamic range and enabling high speed modulation applications approaching several hundred GHz. Even terahertz (THz) processor speed may be within reach with this optoelectronic data processing approach. ■

To the Editor

"I read your editorial 'Green is Good' in the spring 2007 *Interface* with considerable interest. Electrochemists are, generally, onto a good thing because our usual processes are not subject to the Carnot Cycle, but we are involved in batteries and they cannot be described as green. I do not remember when exactly and what newspaper I read this in, but an engineer anxious, one assumes, for early publication did a calculation to decide the cost of energy supplied by batteries compared with that from the mains. His calculation yielded the result that it was 1600 times cheaper from the mains. Now we have made progress in batteries and the cost of power from the mains has risen and he was thinking of lead-acid batteries on stand-by or dry D-cells for flashlights which were the only really common sources in those days, at least 30 years ago. But what is the relative cost now? A casual (not very educated) guess is probably 10 to one. So what I am writing about is that I know from my research we can do better.

"I recently gave a paper at a conference where I explained that by using magnetohydrodynamics, the loss of energy in charging a battery due to electrolyte resistance can be cut down by as much as 95%, and that the same improved performance will occur in discharge by rapidly stirring the electrolyte. In other words, something like 90% of the energy supplied could now become mobile as a battery. Mobile energy is really the reason so many billion batteries are bought every year.

"One of my panels was labeled 'The Wrong Turn Battery Manufacturers Are Making' in which I showed that the possibility of batteries being 'green' is being thrown away as batteries become closer and closer packed to give greater power density and greater energy density, the resistance to charging and discharging is climbing too. The worse case, of course, is Li-ion with smoking laptops extant in all the developed countries. If they at the present stage are put into automobiles, then every hill top will have a smoking car.

"Li-ion is the worst because the best values I've been able to extract from the literature say that the organic electrolytes are always at least 10 times less conducive than water based ones. Taking this into consideration and remembering that the metal parts of a battery are usually about one million times more conductive than the electrolyte—say 5 M H_2SO_4—and that the electroactive material is usually a semiconductor at least, and so about a thousand times more conducting than battery acid, or base, why are we confining the electrolyte to an absorptive spacer material so that little or no convection is possible, remembering that convective transport of ions is by far the most effective in any reasonable (> 10 sq. cm) electrode, and further we are also constraining diffusion and migration."

Sincerely,
Robert N. O'Brien, PhD
Professor Emeritus and Adjunct Professor
Department of Chemistry
University of Victoria
Victoria, BC, Canada

Erratum

In the article, "Gordon E. Moore and His Legacy: Four Decades and Counting," by K. Rajeshwar and F. Roozeboom [*Interface*, Vol. 16, No. 1, pp. 11-13 (spring 2007)], the following correction should be made. On page 12, Fig. 2, the caption should read, "Fig. 2. It is quite conceivable that Si transistors will continue to shrink down to the 4 nm level. This is estimated to occur around 2023 (See Ref. 6)."