San Francisco MEETING HIGHLIGHTS

That "City by the Bay" was host to the 215th ECS meeting. Attendees took advantage of their visit to sample the myriad charms of this well-known town: Fisherman's Wharf, trolley cars, architecture old and new, and too many eateries to count. The meeting itself was also an array of scientific sights and sounds: 47 symposia, 1,579 papers submitted, and over 1,650 attendees. In addition to the technical presentations, ECS meetings are host to interesting technical exhibits, with the San Francisco meeting showing off the equipment and services of 22 exhibitors.

Student activity was a big part of the San Francisco meeting: over 480 international students from 198 academic institutions. The Monday Evening Mixer proved to be as popular as ever, with 71 student poster presentations vying for the awards (see story on page 53). Approximately 100 international students attended the third ECS Student Mixer held at the local San Francisco nightclub, Biscuits and Blues, on Sunday to meet their peers and distinguished members of ECS. ECS President Noel Buckley, along with Board member Doug Hansen and other ECS representatives, greeted students while they enjoyed delicious southern cuisine. Student representatives from established Student Chapters such as the University of California, Berkeley and University of Central Illinois shared their local chapter activities while many student representatives expressed interest in starting a student chapter.

Quantum Cascade Lasers

The ECS Lecture, entitled, "Quantum Cascade Lasers for the Mid- to Far-Infrared: Band-Structure Engineering, Beam Engineering, and Applications," given by **Federico Capasso,** traced the path from invention to exciting advances in the physics, applications, and commercialization of the quantum cascade laser (QCL). The speaker was introduced to the Monday morning plenary session audience by D. Noel Buckley, ECS President. Prof. Capasso has been the Robert L. Wallace Professor of Applied Physics at Harvard University since 2003. He had a distinguished 27-year career at Bell Labs after completing a Doctor of Physics degree from Rome University. Among numerous awards and recognitions, including the King Faisal International Prize for Science, the American Physical Society Arthur Schawlow Prize, and the IEES Edison Medal, Prof. Capasso is a member of both the National Academy of Sciences and the National Academy of Engineering, and he is a Fellow of the American Academy of Arts and Sciences.

The speaker noted that the QCL has emerged as a revolutionary light source covering the wavelength range from 3 μm to 350 μm. The large "design space" enables one to tailor its performance at will for a broad range of applications that were expertly covered in the talk. These include sensing of atmospheric and environmental gases (*e.g.*, NO_x from auto exhausts and ozone) and ammonia detection (using a breath analyzer), and its versatility

***Federico Capasso**, of Harvard University, delivered **The ECS Lecture** entitled "Quantum Cascade Lasers for the Mid- to Far-Infrared: Band-Structure Engineering, Beam Engineering, and Applications" at the 215th ECS Meeting in San Francisco.*

*The **2009 Gordon E. Moore Medal for Outstanding Achievement in Solid State Science and Technology** was presented to **C. Grant Willson** (right) by ECS President **Noel Buckley** at the ECS meeting in San Francisco. The Moore Medal is one of the Society's most prestigious awards.*

for field measurements in this area was exemplified by application for pollution monitoring in Beijing during the recent Olympics. Unlike conventional diode lasers whose emission is limited to one color (depending on the bandgap of the semiconductor active material), the QCL emission color can be tuned over a very broad range by controlling the layer thickness. Prof. Capasso referred to this QCL advantage as "elimination of band-gap slavery." Thus Prof. Capasso explained that a QCL does not use bulk semiconductor materials but instead a periodic series of thin layers forming so-called superlattices. Laser emission is achieved through inter-sub-band transitions in a repeated stack of semiconductor superlattices ("multiple cascades"). The first QCL was demonstrated with the InGaAs/InAlAs superlattices lattice-matched to an InP substrate. Prof. Capasso noted that the use of Group III metal nitrides (*e.g.*, GaN) for QCLs is an exciting prospect.

Another sphere of application for QCLs is in the homeland security area because of the applicability of THz imaging to look inside packages in a non-destructive manner. The broadband spectral coverage also enables use in identifying and quantifying complex molecules such as those in toxic chemicals, explosives, and drugs. Unguided QCL emission in the 3-5 μm atmospheric window will be a low-cost alternative to optical fibers for high-speed internet access. The concluding portion of this fast-paced and information-packed lecture was a look into the future, including aspects related to beam engineering, and strategies to achieve good spatial coherence (*e.g.*, plasmonic collimators), an Achilles heel with conventional semiconductor diode lasers.

The Gordon E. Moore Award Lecture

The award lecture, entitled, "High Resolution Imaging Technology: A View of the Future" was given by **C. Grant Willson** immediately following the conclusion of the ECS Lecture. The awardee earned his undergraduate and graduate degrees at UC Berkeley. He joined the University of Texas in 1993 after a stellar career at IBM at the Almaden Research Center in San Jose, California. Prof. Willson was awarded the U.S. National Medal of Technology and Innovation in 2008 (see *Interface*, spring 2009, p. 40), and his work has been recognized by numerous professional societies and organizations including the ACS, AIChE, SRC, and SPIE. He is a member of the National Academy of Engineering and is a Fellow of PMSE and SPIE.

Dr. Willson began his very entertaining talk by noting that the drive to manufacture semiconductor features with ever smaller features (as described by Moore's law) has led in turn to amazing improvements in imaging materials science and technology for over three decades. Thus he noted the economic truth that billions of dollars have been spent in efforts to enable the printing of ever smaller transistors with gates in the nanometer width regime. However he cautioned that these "nanolithography" processes are becoming increasingly expensive and the high process cost threatens the economics and future of the semiconductor microelectronics industry. The speaker then turned to the key role that chemists can play in the development of

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***Quallion, LLC** received a Silver Level **Leadership Circle Award**, for ten years of corporate membership with ECS, at the plenary session on Monday. **Hisashi Tsukamoto** (right) received the award from ECS President **Noel Buckley**.*

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photoresists. He discussed the underlying principle behind chemically amplified resists—a disruptive approach in the development of photoresist technology. Correspondingly, the wavelengths have shrunk from 436 nm to 157 nm and to the vacuum ultraviolet region where, the speaker noted, everything is opaque. Future "light" sources will likely access the 11-13 nm wavelength region.

Dr. Willson pointed out that ultimately the chemistry could prove limiting because of diffusion spreading and latent image edge effects. He showed a telling "Triangle of Death" chart with the dose, resolution, and line edge roughness at the apex potions of the triangle. He also showed a chart of exposure tool price vs. time, signaling the increasing cost of tools as resolution increases. He made an interesting analogy with the speed of commercial aircraft vs. time, showing the diminishing returns on investment as the speed increases beyond a certain point (as witnessed by the Concorde case). The speaker also noted alternative approaches to lithography not requiring an optical lens such as the "soft lithography" developed by Whitesides and co-workers. But processing speed is an issue with such alternative approaches.

The final topic of discussion was futuristic approaches to lithography such as the Step and Flash Imprint variant (SFIL) that is designed to allow the fabrication of high resolution, high aspect ratio images that can be aligned with precision. The SFIL process can faithfully replicate with 2.4 nm resolution and its applicability to non-CMOS devices and 3D replication for vertical device integration was finally presented.

***Permascand AB** received a Bronze Level **Leadership Circle Award**, for five years of corporate membership with ECS. Receiving the award was **Lars-Ake Näslund** from Permascand AB.*

***ZSW, Center for Solar Energy & Hydrogen Research**, received a Bronze Level **Leadership Circle Award**, for the 5 years of corporate membership with ECS. ECS President **Noel Buckley** (left) presented the award to ZSW representative **Pierre Kubiak**.*

Organic Sensors and Electronics in Medicine

The very popular "XYZ... "For the Rest of Us" talk series on Sunday evenings, sponsored by the Education Committee, made its re-appearance with a talk entitled, "Development of Organic Sensors and Electronics in Medicine and for Point-of-Care Patient Health Monitoring in Real Time," by **Vijay K. Varadan** of the University of Arkansas. The theme of this lecture was the development of a real-time health monitoring strategy that utilizes the latest advances in sensor science, wireless technology, nanotechnology, and computer science. Various point-of-care monitoring of a patient's vital signs such as heart rate, respiration, body temperature, etc., as well as other diagnostics including gait analysis and skin response were illustrated with the use of videos and animations. Applications to sleep disorder diagnostics and the treatment of neurological disorders were also discussed. Sensor arrays embedded in footwear, sleepwear, and clothing enable the signals to be transmitted wirelessly to a personal computer. The speaker also alluded to a fledgling global nanomedicine initiative based on this paradigm that already has six subscribing member countries.

*ECS President **Noel Buckley** (at the lectern) invites guests to be seated and enjoy the first part of the meeting—the food! In the background, from left to right are Executive Director **Roque Calvo**, and past Presidents **William Smyrl**, **Richard Alkire**, and **Elton Cairns**.*

*Some Society Officers converse before the meeting is called to order. From left to right are Senior Vice-President **Paul Natishan** (left), Third Vice-President **Esther Takeuchi** (center), and Second Vice-President **Bill Brown** (right).*

SCENES from the ECS Annual Business Meeting

The **ECS Annual Business Meeting** is a feature of the spring meetings. Society officers give reports on various aspects of ECS's activities; the Student Poster Session award winners (see story on page 53) are presented at this event; and members old and new have time to catch up with each other and enjoy a delicious luncheon.

*Many past Presidents customarily attend the Annual Business Meeting. From left to right are **William Smyrl**, **Jerry Woodall**, **Richard Alkire**, **Elton Cairns**, **Kathryn Bullock**, **Dennis Hess**, **Robin Susko**, and **Barry MacDougall**.*

*ECS Treasurer **John Susko** takes a last look at the numbers.*

*Incoming Third Vice-President **Fernando Garzon** (left) and President **Noel Buckley** enjoy a moment before the business part of the meeting begins. (ECS past Presidents are seated in the second row; see previous photo).*