



Vienna

Meeting Highlights

ECS Holds Its First Meeting in Vienna

Stephansplatz became a familiar stop on the Metro system in Vienna as many attendees made their way between the Austria Center and the many delights the city had to offer, from Wiener schnitzel and sacher torte, the opera houses and museums, or even a pleasant walk along the river or canal. Just around the corner from the IAEA headquarters, the Austria Center was the setting for over 3,200 meeting attendees at the 216th ECS Meeting in October.

Of the 3,225 papers submitted for the meeting, 118 were submitted to the Student Poster Session. (For the award winners, see the Student News section of this issue.) The meeting was host to some special conferences, including Solid Oxide Fuel Cells XI and EuroCVD/CVD 17, both with a very full program of standing-room only talks and special banquets and tours. The meeting also hosted the *In Situ* Diagnosis of PEM Fuel Cells Conference sponsored by the German Federal Ministry of Education. There were two memorial symposia as well, one in honor of Brian Conway and the other in honor of Bill Yen.

Over 80 sponsors and exhibitors were on hand to supplement the technical program; and ECS recognized some long-standing Corporate Members for their support of the Society. A "Hot Topic" lecture was given by E. Jennings Taylor on "A Small Business Model for Facilitating Partnerships in the Innovation Ecosystem." The IE&EE Division continued its outreach to high school-aged students, this time at the Gymnasium und Realgymnasium des Instituts Neulandschule in Vienna (see story in this issue).

Zinc Alloys for the Corrosion Protection of Steel

The ECS Lecture, "Electrochemical Design of Novel Zinc Alloys for the Corrosion Protection of Steel," given by **Martin Stratmann**, charted the progress of the use of zinc and its alloys containing Mg as corrosion protection coatings for steel, and closed with a vision for systematic development of corrosion coatings. The speaker was introduced to the Monday morning plenary session audience by the ECS President, Paul Natishan. Professor Stratmann studied chemistry at the Ruhr Universität Bochum and received

his diploma in 1980. He finished his PhD in 1982 at the Max Planck Institut für Eisenforschung in Dusseldorf with H. J. Engell and then did a post-doctoral stint with Ernest Yeager at Case Western Reserve University. The habilitation in physical chemistry followed in 1992 at the University of Düsseldorf and in 1994, he took over the chair in corrosion science and surface engineering at the University of Erlangen. Since 2000, he has been a scientific member of the Max Planck Gesellschaft and Director at the Max Planck Institute für Eisenforschung in Düsseldorf, where he heads a department of interface chemistry and surface engineering. (Further details on



MARTIN STRATMANN delivered *The ECS Lecture* at the plenary session of the 216th ECS Meeting in Vienna, Austria. Dr. Stratmann's talk was on "Electrochemical Design of Novel Zinc Alloys for the Corrosion Protection of Steel."

his background and affiliations may be found in the fall issue of *Interface*, p. 15.)

The talk was organized around three topics, namely: commercial Zn-based coatings, Zn–Mg alloys, and Zn–Mg–Al alloys. Prof. Stratmann noted the early history of hot-dip galvanizing, which is the process of coating iron, steel, or aluminum with a thin zinc layer by dipping the metal to be protected in a molten bath of zinc. He noted that there were very few examples of Zn alloys during this period and the industry was dominated by the use of pure Zn as opposed to Zn alloys. He then turned to the use of Zn–Mg alloys and discussed the influence of the Mg component in the improved corrosion protection. A number of intermetallic phases can be identified at the substrate/coating boundary. A brief discussion of the cathodic corrosion protection mechanism wherein the Zn (or Zn alloy) layer acts as sacrificial anode, and interfacial defect chemistry details associated with the steel/zinc alloy/organic (polymer) layer assembly, were shown to be a key factors in the overall efficacy of corrosion protection.

The electrochemistry of buried metal/polymer interfaces was discussed next and the scanning Kelvin probe was shown to be an invaluable tool for mapping potential gradients around localized corrosion sites. The behavior of Zn and Zn–Mg alloy-based interfaces was compared and contrasted; it was

shown how potential inversion in the latter case avoided delamination of the polymer layer thus affording enhanced protection for the coated substrate. This contrasting behavior was rationalized on the basis of semiconductor physics principles because ZnO and ZnMgO, formed *in situ* at the interface as a result of sacrificial anodic oxidation, are wide-band gap semiconductors. The talk then focused on the influence of Al addition to the Zn–Mg alloy layer and how it affects the oxide microstructure.

The final part of this talk centered on a vision for systematic coating development based on combinatorial principles. A novel flow-type scanning droplet cell, which facilitates the screening of a large number of alloy compositions, was described. This novel approach departs from the classical methodology for choosing corrosion protection coatings in that the initial choice of a particular coating composition is systematic rather than empirical.

2009 Olin Palladium Award Lecture

An eminently successful experiment in Vienna, Austria was the scheduling of the award lecture on Tuesday evening at 5:00 PM (instead of Monday or Wednesday mornings when award lectures had usually been scheduled at

prior meetings.). The awardee, **Dieter M. Kolb**, was introduced in affectionate and admiring terms by his long-term colleague and friend, Richard Alkire (a past ECS President) to a packed audience. This introduction not only detailed the professional accomplishments but also touched upon the esteem with which Prof. Kolb is held by his associates and colleagues in the global electrochemical community. One such communal activity, which Prof. Alkire referred to, was an annual mountain-climbing picnic that Prof. Kolb organizes with the members and visitors in his research group. At the outset of his lecture, Prof. Kolb linked hiking and mountain-climbing with overcoming scientific challenges in terms of the satisfaction one gets by scaling the terrain or heights; but he noted that this feeling was then quickly followed by the preoccupation with surmounting the next challenge. This analogy and the implied message that one cannot rest on one's laurels particularly left an indelible impression on this reporter (KR).

Prof. Kolb's many accomplishments are detailed in the fall issue of *Interface* (p. 15). In brief, he studied physics at the Technical University of Munich where he did his thesis work on the electron spin resonance of radical anions under the tutelage of the late Heinz Gerischer. He then spent two post-doctoral years at Bell Laboratories in Murray Hill, NJ, studying the optical properties of electrode surfaces by *in situ* UV-vis reflectance spectroscopy. He re-joined Gerischer, now at the Fritz-Haber-Institut der Max Planck-Gesellschaft in Berlin, as a group leader in electrochemical surface science. Since 1990, he has been at the University of Ulm as a full professor and Director of the Institute of Electrochemistry. Prof. Alkire, in his introduction, glowingly referred to Kolb's pioneering atomic-level studies of electrode surfaces, particularly, the surface reconstruction of Au(100) planes, under-potential deposition (UPD) of Cu and Ag on Au (111), and *in situ* scanning tunneling microscopy studies of metal deposition on self-assembled monolayer (SAM) modified Au surfaces—a body of elegant work spanning some four decades. Space constraints prohibit a discussion here of all his awards and recognitions but may be found in the above-mentioned profile.

Prof. Kolb's fast-moving and highly informative award lecture was entitled, "The Metal-Solution Interface: What We Know and What Needs to be Done." He organized his lecture around a description first of the parallel plate condenser model for the electrified metal-solution interface. He then focused on the atomic level structure of this interface approaching it both from



DIETER M. KOLB (right) received the 2009 Olin Palladium Award from ECS President **PAUL NATISHAN**. The award is one of the Society's most prestigious, and recognizes outstanding contributions to the fundamental understanding of all types of electrochemical and corrosion phenomena and processes



HENRY S. WHITE (right) received the 2009 Carl Wagner Memorial Award from ECS President **PAUL NATISHAN**. The award recognizes mid-career achievement and excellence in research areas of interest of the Society, and significant contributions in the teaching or guidance of students or colleagues in education, industry, or government.

the metal side and from the solution side. His final discussion of reactive interfaces was unfortunately cut short by time constraints. An award reception soon followed where the attendees from the talk could continue informal discussions over wine and cheese.

After reminding the audience about the salient aspects of the metal–solution interface (including the compact and diffuse parts of the double layer) and the tremendous field strengths existing across the atomic level dimensions of this interface, Prof. Kolb presented data on the point of zero charge and double layer capacitances (C_{DL}) for a variety of metal–solution interfaces. He noted the rather remarkable result that C_{DL} values at negative potentials in 0.1 M H_2SO_4 leveled off to $\sim 20 \mu F/cm^2$ regardless of the particular metal. At positive potentials the parent metal surface was covered by an adlayer of anions. Prof. Kolb then turned to measurements on SAM-modified metal–solution interfaces. The alkyl chain length in the thiol SAM could be systematically varied to tune in effect the gap thickness in the parallel plate condenser model. Analysis of the capacitance data yielded eminently reasonable values for the dielectric constant of the organic phase. When the SAM backbone was changed from an insulating alkyl chain

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ECS President **PAUL NATISHAN** (photo at left, fifth from the left) inducted the 2009 Class of ECS Fellows. Standing from left to right are: **KOHEI UOSAKI**, **MANFRED ENGELHARDT**, **UZIEL LANDAU**, **DOLF LANDHEER**, (President Natishan), **TOM FULLER**, and **THOMAS P. MOFFAT**. **IKUZO NISHIGUCHI** (photo at right) was also named to the 2009 Class of ECS Fellows. Missing from the photo were **VLADIMIR S. BAGOTSKY**, **UGO BERTOCCHI**, and **PETER HESKETH**.





Leadership Circle Awards were presented to a number of Corporate Members for their years of membership. President **PAUL NATISHAN** (center) presented the awards to (from left to right): **STEF LEEMANS**, PEC North America, Bronze Level (5 years); **ROB DARLING**, UTC Power, Silver Level (10 years); (President Natishan); **HILMI BUQA**, Leclanche S.A., Gold Level (25 years); and **STEPHAN FELLNER**, GAIA Akkumulatorenwerke, Bronze Level (5 years).

to aromatic, corresponding C_{DL} data translated to unreasonable values for the dielectric constant.

Prof. Kolb turned his attention to the analysis of potential distribution across the double layer. He discussed the extreme utility of surface state spectroscopy and monitoring binding energy shifts of wprobe atoms (e.g., S 2p and N 1s) across the double layer as referenced against the metal Fermi level. He used mercaptopyridine as the solution probe adsorbed on Au(111) in NaOH electrolyte. The discussion then turned to the microscopic structure of the electrified metal-solution interface with data drawn from measurements on As redox probe on Pt (111) surfaces in 0.1 M H_2SO_4 . Work function data on immersed Au electrodes were also presented. Other metal-centric data included: real space imaging of single crystal electrode surfaces, especially in terms of defects; potential-dependent lattice parameter shifts for nanoporous Pt; and *in situ* X-ray diffraction surface stress-charge response profiles for Au(111) in NaF.

A discussion of the solution side of the electrified interface included a brief summary of what we can glean from simulations of how ions are arranged in contact with Pd(111) or Ag(100) surfaces. Experimental access to this picture is possible using distance-tunneling spectroscopy but with the attendant handicap that the structure in all probability is perturbed by the probe itself.

A very brief discussion on reactive interfaces capped the lecture with attempts to locate the Gouy-Chapman minimum on Pt(111), Rh(111), or Ir(111) using AC impedance measurements on carefully-prepared interfaces. Work done by his collaborator, Tamás Pajkossy, was mentioned by the speaker who noted that no point of zero charge can be located on these (reactive) interfaces, attesting to the fact that the electrode surface is always covered with strongly interacting solution species.

Electrochemistry and Nuclear Waste Performance Assessment

The Sunday XYZ lecture entitled, "Electrochemistry and the Performance Assessment of Nuclear Waste under Permanent Disposal Conditions," was given by Prof. **David Shoosmith** of the Department of Chemistry at the University of Western Ontario (London, Ontario, Canada). This tutorial on the electrochemical aspects of nuclear waste disposal (obviously a topic of much current interest and relevance worldwide) was organized into a discussion of the types of nuclear waste, key properties of relevance to storage and disposal, corrosion of Cu waste containers, and finally the elaboration and validation of an electrochemical model of container corrosion and radionuclide release. The talk centered mainly on high level nuclear waste as

opposed to the low level waste typical of use in medicine and analytical laboratories. Permanent disposal of this waste involves containment within a deep geological repository ranging from granitic rock (Canada), sedimentary clay (Switzerland), to dry desert (Nevada, U.S.). The speaker noted that multiple barriers to radionuclide are sought with no common mode of failure.

The first point addressed was why copper was the container material of choice for this application. Engineered barriers, as opposed to natural geologic barriers, were then discussed. Models must be capable of assessing with reliability the evolution of repository behavior from the initial excavated damaged state to the original undisturbed state. Given the long time scales involved (ca. 100 years) this is a unique challenge for engineered structures. The talk centered on the roles that electrochemical principles can play in the mechanistic understanding of container corrosion, evolution of corrosion damage, groundwater redox conditions, and the decay of radiation fields with time. Computational models to aid these predictions were discussed with the ultimate goal of providing feedback on the engineering design of optimized barriers with acceptable performance and cost. ■

Meeting Highlights was prepared by Krishnan Rajeshwar and Mary Yess, Interface's Editor and Managing Editor respectively.