

Special Meeting Section



221st ECS Meeting

Seattle, WA

May 6-10, 2012

Washington State Convention Center and the Sheraton Seattle Hotel



Seattle, WA

ECS
221st ECS Meeting

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Welcome to Seattle! We are pleased to venture into this city again for the 221st ECS Meeting. This major international conference will be held at the Washington State Convention Center (WSCC) and the Sheraton Seattle Hotel, and will include 45 topical symposia consisting of 1,657 technical presentations. You are invited to participate not only in the technical program, but also in the other social events planned for the meeting.

Featured Speakers

PLENARY SESSION AND THE ECS LECTURE

Will It Be a Tank of Lithium to Drive Our Next Car?

by Bruno Scrosati



**Monday, May 7
1700h
Ballroom 6A, Level 6, WSCC**

Back in 1800, when Alessandro Volta, professor at the University of Pavia in Italy, unveiled his “electric pile” to Napoleon Bonaparte, he could not have imagined that his invention—mainly the fruit of a dispute with his colleague-competitor Luigi Galvani at University of Bologna—would have opened a route that, via various progressive technological evolution steps, did eventually lead to the development of the electrochemical power source that today dominates the consumer electronics market. This is the lithium battery, currently produced at a rate of several billions of units per year. This talk will illustrate the evolution of

these important energy storage devices, from their early stages to the present worldwide intense research activities aimed to further improve their properties and characteristics. Also discussed will be the various new electrode and electrolyte materials that are currently being investigated as a way to upgrade the energy content of the batteries so as to deal with the new challenges opened by the expected advent of a wide road electrification. Lithium batteries are facing a second, new age: as the first one led to the revolution in the consumer electronic market, the new one is expected to favor an epoch-making change in vehicle transportation.

BRUNO SCROSATI is Senior Professor of Electrochemistry at the University of Rome La Sapienza. In 1990 he was the George T. Piercy distinguished visiting professor in the Department of Chemical Engineering & Materials Science at the University of Minnesota, and in 1991 was a visiting professor in the Department of Chemical Engineering & Materials Science at the University of Pennsylvania. Presently, he is a visiting professor in the Department of Energy Engineering at Hanyang University in Seoul, Korea. In 1990-92 he was President of the International Society of Solid State Ionics and in 1996-1998 President of the Italian Chemical Society. He was elected Vice-President (2000) and President (2003-2004) of The Electrochemical Society. In 1996 he received the title of Doctor in Science *honoris causa*, Hon. Dsc. from the University of St. Andrews in Scotland. In 1997 he received the ECS Battery Division Research

Electrochemical Impedance Spectroscopy

by Mark Orazem



Monday, May 7
1450h
Ballroom 6A, Level 6, WSCC

Electrochemical impedance spectroscopy is a powerful, sensitive, and minimally invasive *in situ* electrochemical technique that can provide quantitative descriptions of electrochemical systems. The applications are broad, including corrosion and corrosion control; electrochemical kinetics and mechanisms; electronic and ionic conducting polymers; semiconducting electrodes; semiconductors, solid electrolytes, and electronic conductors; energy storage, batteries, fuel cells; and biological systems. While instrumentation is readily available to make impedance measurements, the challenge lies in interpreting the spectra in terms of physically meaningful properties. This talk will provide an introduction to impedance spectroscopy, including an historical perspective, physical interpretation of the measurement, and challenges for the future.

MARK ORAZEM obtained his BS and MS degrees from Kansas State University and his doctorate in 1983 from the University of California, Berkeley. In 1988 he joined the faculty of the University of Florida where, since 1992, he holds the position of Professor of Chemical Engineering. Orazem's work on electrochemical impedance spectroscopy has encompassed corrosion, fuel cells, batteries, biomedical processes, and electronic materials. His measurement model approach, developed in collaboration with researchers in France and the University of South Florida, provides a powerful method for statistical analysis of impedance data. Orazem and his collaborators have developed a new interpretation of the frequency dispersion seen in the impedance response of oxides. These concepts have been applied by the leading manufacturer of heads for computer hard drives to monitor the oxide thickness during fabrication. With Bernard Tribollet, he has co-authored a textbook on impedance spectroscopy, published in 2008 by John Wiley & Sons as part of The Electrochemical Society monograph series.

Orazem has delivered plenary and keynote lectures on impedance spectroscopy, including plenary lectures delivered at the Electrochemical Methods in Corrosion Research conference (EMCR 2006, Dourdan, France), the 7th International Symposium on Impedance Spectroscopy (2007, Arg  les sur Mer, France), and the XXVI Congreso de la Sociedad Mexicana de Electroqu  mica (2011, Mexico City). He organized the 6th International Symposium on Electrochemical Impedance Spectroscopy, held in Cocoa Beach, Florida in May 2004, and served as Guest Editor for a special issue of *Electrochimica Acta* on Electrochemical Impedance Spectroscopy, published in January 2006. Orazem delivers courses on impedance spectroscopy for companies and professional societies. In 2011, his courses were offered for ECS, GenTex Corporation, the Rocky Mountain Section of the Materials Research Society, la Sociedad Mexicana de Electroqu  mica, and l'Institut Carnot CIRIMAT in Toulouse, France.

Orazem has been recognized as a Fellow of The Electrochemical Society. He was an Associate Editor for the *Journal of The Electrochemical Society* for 10 years, and he is now the President of the International Society of Electrochemistry. He was recognized as the 2005 College of Engineering Distinguished International Educator, he received the 2006 Excellence in Teaching Award from the student chapter of the AIChE, and he received the 2008 UF Blue Key Distinguished Professor Award. In recognition of his contributions to their training program, BP Azerbaijan presented Orazem with their 2005 Outstanding Service Award.

Award. In 2004 he won the XVI edition of the Italgas Prize, noted for science and environment, specifically for "his studies, which provide consistent evidence that the new, morphologically optimized materials approach the performance levels requested for batteries and fuel cells designed for electric vehicle applications." In 2005 he was named a Fellow of The Electrochemical Society and in 2007 a Fellow of the International Society of Electrochemistry. In 2006 he received the Volta Medal of the ECS European Section, and in 2007 the "Sigillo d'oro" Medal from the Italian Chemical Society. In 2008 he received an honorary doctorate in science and technology from the Chalmers University of Technology, Goteborg, Sweden.

Dr. Scrosati is the European editor of the *Journal of Power Sources* and a member of the editorial boards of various international journals, which include *Solid State Ionics*, *Journal of Applied Electrochemistry*, *Progress in Solid State Chemistry*, and the *Journal of New Materials for Electrochemical Systems*. Professor Scrosati has coordinated several national and international research projects devoted to the studies of materials for energy storage electrochemical devices. He was Chair of the 1st International Conference on Lithium Batteries (IMLB 1), the 1st International Conference on Polymer Batteries and Fuel Cells (PBFC 1), promoter and chair of the Japan-Italy-Germany Electrochemical Seminar, and of the Korea-Italy-Swedish Electrochemical Seminar. All these have become regular and established international events. He has been an invited speaker at many international conferences. Prof. Scrosati is author of more than 450 scientific publications, 30 books and chapters in books, and 18 patents. His H-factor is 48.

THE VITTORIO DE NORA AWARD LECTURE

Lithium-Sulfur and Lithium-Air: The Superbatteries of the Future

by Bruno Scrosati



Monday, May 7
1400h
Ballroom 6A, Level 6, WSCC

Li-ion batteries today exceed by a factor of at least 2.5 any competing technology, thanks to the high value of energy density, i.e. 150 Wh/kg-1 and 650 Wh/l-1. Due to their unique features, these batteries are the power sources of choice for the portable electronics market (including popular products such as cellular phones, laptop computers, MP3s, etc.) and are aggressively entering in the power tool equipment market and, in particular, in the emerging sustainable vehicle market.

However, the present Li-ion batteries, although commercial realities, are not yet at such a technological level to meet the power requirements of efficient hybrid or electric vehicles. Reduction in cost, enhancement in safety and rate, and, especially improvement in energy density, are mandatory requirements. It is now clear that jumps in energy density may only be achieved by renewing the lithium battery concept, passing from conventional intercalation to an advanced conversion chemistry. The most significant examples are provided by the lithium-sulfur and the lithium-air systems, in principle capable to provide 3-5 times enhancement in energy density. However, the practical exploitation of these "superbatteries" is still hindered by a series of issues, mostly associated with electrolyte incompatibility with electrode materials.

In this presentation, after a brief introduction on the basic characteristics of lithium-ion cells, the research currently in progress in our laboratory for upgrading the performance of lithium-sulfur and lithium-air batteries are reviewed and discussed. It will be shown that most of the operational issues may be effectively addressed by the use of innovative, stable electrolytes, combined with the development of appropriate electrode morphologies.

The Lithium Battery

by Peter Bruce



**Monday, May 7
1535h
Ballroom 6A, Level 6, WSCC**

The rechargeable lithium battery is one of the most successful electrochemical technologies of the past few decades. It has transformed portable electronics, is the technology of choice for battery electric vehicles, and will have a key role in balancing the intermittent supply of electricity from renewable sources with consumer demand. However, to meet the needs of new markets in the medium to long term, new generations of rechargeable lithium batteries are necessary and this in turn requires a step-change in the underpinning electrochemical science.

The operation of Li-ion batteries depends on Li intercalation. The talk will consider the effect of nanostructured intercalation electrodes for Li (nanotubes, nanowires, and mesoporous solids) on the intercalation process. Such nanostructured materials, in which lengths are controlled simultaneously on the micron, nano, and atomic scale, will be compared with the equivalent bulk and nanoparticulate intercalation hosts. To meet the long term needs of energy storage it is necessary to go beyond lithium-ion batteries. One approach is the lithium-air battery, which theoretically could deliver a battery electric vehicle with a 300 mile driving range. The underlying scientific challenges that face technological realization of this energy storage device will be discussed.

PETER BRUCE FRS, FRSE, FRSC, is the Wardlaw Professor of Chemistry at the University of St. Andrews, Scotland. His research interests embrace materials chemistry and electrochemistry, especially the synthesis and characterization of new and novel materials (extended arrays and polymers) with new properties or combinations of properties for new generations of lithium batteries. Recent efforts have focused on the synthesis and understanding of nanoelectrodes for lithium-ion batteries, including nanowire/nanotube intercalation anodes (TiO₂) and mesoporous cathodes (LiMn₂O₄), novel approaches to high capacity lithium batteries (the lithium-air battery), and the influence of order on the ionic conductivity of polymer electrolytes. His research has been recognized by a number of awards and fellowships, including from the Royal Society, the Royal Society of Chemistry, the German Chemical Society, and The Electrochemical Society. He was elected to the Royal Society (UK Academy of Sciences) in 2007 and the Royal Society of Edinburgh (Scottish Academy of Sciences) in 1994.

Short Courses & Tutorials

Six Short Courses will be offered in conjunction with the 221st ECS Meeting. These courses will be held on Sunday, May 6, 2012, from 0900h to 1630h. The registration fee is \$425 for ECS members and \$520 for nonmembers. **Students are offered a 50% discount.** The registration fee for the short courses covers the course, text materials, continental breakfast, luncheon, and refreshment breaks; it is not applicable to any other activities of the meeting. The half-day tutorial is \$212.50 (for ECS members and nonmembers), \$106.25 (for ECS student members and nonmembers), and \$25 if you are an employee of an ECS corporate member organization. **The deadline for registration for a course is April 6, 2012.** Written requests for refunds will be honored only if received at ECS headquarters before April 13, 2012. **Pre-registration is required.** All courses are subject to cancellation pending an appropriate number of advance registrants.

Visit the ECS website for full course descriptions and instructor biographies.

SHORT COURSE #1

**Enantioselective, Electrochemical Sensors:
Design, Response Characteristics, and Applications**
Raluca-Ioana van Staden, Instructor

This course is intended for chemists, physicists, materials scientists, and engineers with an interest in applying electrochemical sensors to enantioanalysis. The discrimination between enantiomers using enantioanalysis is becoming one of the most important fields of modern analytical chemistry, especially for pharmaceutical analysis and clinical analysis/biomedical analysis. The course is best suited for an attendee who has basic knowledge of electrochemical sensors. The attendee will develop a basic understanding of the principles of molecular recognition of enantiomers, types of electrochemical sensors which can be used for enantioanalysis, design of enantioselective, electrochemical sensors, response characteristics, and the reliable application of the electrochemical sensors in enantioanalysis of compounds of pharmaceutical and clinical/biomedical interest. The topics to be covered include:

- Principles of molecular recognition of enantiomers using electrochemical sensors;
- Types of enantioselective, electrochemical sensors used in enantioanalysis: enantioselective, potentiometric membrane electrodes; enantioselective, amperometric sensors, stochastic sensors, biosensors, immunosensors, multimode sensors; general aspects;
- Mechanism of potential development and enantioselectivity for potentiometric, enantioselective membrane electrodes;
- Design of enantioselective, electrochemical sensors;
- Response characteristics of enantioselective, electrochemical sensors;
- Simultaneous assay of enantiomers using enantioselective, electrochemical sensors; and
- Applications of enantioselective, electrochemical sensors in pharmaceutical and clinical/biomedical analysis.

SHORT COURSE #2

Fundamentals of Electrochemistry
Jamie Noël, Instructor

This course is suited to people with a physical sciences background who have not been trained as electrochemists, but who want to add electrochemical methods to their repertoire of research approaches. There are many fields in which researchers originally approach their work from another discipline but then discover that it would be advantageous to understand and use some electrochemical methods to complement the other work that they are doing. The course will cover the following areas:

- Introduction and Overview of Electrode Processes
- Chemical vs. Electrochemical Thermodynamics
 - cell potentials, Nernst equation, electrode-solution interface, double-layer structure, and adsorption
 - applications in analytical electrochemistry and sensors
- Chemical Stoichiometry vs. Faraday's Law
 - coulometry, bulk electrolysis
- Chemical vs. Electrochemical Kinetics
 - electrode reactions, rates, mechanisms and rate constants, mass transport, Butler-Volmer, Tafel, and Levich equations
- Kinetic Methodology
 - potential step and sweep methods, polarography, controlled-current techniques, controlled mass transport approaches, rotating electrodes, microelectrodes, electrochemical impedance spectroscopy
- Electrochemical Instrumentation
 - voltmeters, potentiostats, cells and time permitting:

- Scanning Probe Techniques
 - scanning electrochemical microscopy, AFM, etc.
- Coupled Characterization Methods
 - modified electrodes, spectroelectrochemistry, *in situ* neutron scattering, surface analysis, etc.

SHORT COURSE #3

Basic Impedance Spectroscopy

Mark E. Orazem, *Instructor*

This course is intended for chemists, physicists, materials scientists, and engineers with an interest in applying electrochemical impedance techniques to study a broad variety of electrochemical processes. The attendee will develop a basic understanding of the technique, the sources of errors in impedance measurements, the manner in which experiments can be optimized to reduce these errors, and the use of graphical methods to interpret measurements in terms of meaningful physical properties. The topics to be covered include:

- The motivation for using impedance spectroscopy advantages as compared to other transient techniques and the conditions under which its use is ideally suited;
- The basic concepts of how impedance is measured;
- Proper selection of experimental parameters;
- Graphical representation of impedance data, including methods to extract some physically meaningful parameters;
- Constant-phase elements;
- Application of electrical circuit analogues; and
- The meaning of the Kramers-Kronig relations.

The concepts will be illustrated by applications to different systems including corrosion, fuel cells, batteries, and transport through membranes such as skin. A list of suggested references will be provided.

This course is the first in a two course sequence offered at alternating ECS meetings by Professor Orazem. The second course in the series, "Advanced Impedance Spectroscopy," introduces model development based on proposed reaction mechanisms, statistical analysis of impedance data, and regression analysis.

SHORT COURSE #4

MEMS Reliability and Packaging

Slobodan Petrovic, *Instructor*

This course provides a comprehensive overview of a broad array of MEMS packaging and reliability issues. While some prior knowledge by the participants of MEMS in general is helpful, the packaging discussion will require a fairly detailed explanation of the principles of operation, fabrication methods, and materials used in building MEMS structures. The course is therefore open to participants with no prior MEMS knowledge and would provide a reasonably broad general introduction into the field. Because each MEMS design deserves its own distinctive packaging approach, packaging considerations will be, whenever possible, illustrated using specific device examples; and every opportunity will be used to demonstrate the uniqueness of a packaging solution and its interaction with a micromachined structure. Using this dynamic teaching method, in addition learning in depth about packaging and reliability, the participants will have the opportunity to gain knowledge about MEMS in general through the eyes of a packaging and reliability specialist.

A broad range of MEMS devices will be discussed while a particular emphasis will be placed on sensors and actuators used in industrial, medical, and automotive applications. Extensive case studies that will be used to most effectively demonstrate diverse packaging principles for devices such as accelerometers, pressure sensors, and digital micromirror devices.

The course will be divided in 2 major sections: general MEMS competence; and packaging and reliability. The following major topics will be covered:

- Fabrication technologies
- Materials
- Design and device physics
- Main MEMS types
- Integration aspects
- Selected industrial application
- Design considerations
- Types of packaging
- Quality control
- Reliability
- Failure analysis

SHORT COURSE #5

Scientific Writing for Scientists and Engineers

Noel Buckley, *Instructor*

Do you sometimes have trouble explaining your results when you write a paper? Do reviewers often comment that your data and discussion is unclear? Do editors complain about your English usage? If so, then this is the course for you! In this course you will learn how to improve your scientific writing. You will learn how to write a paper that gets accepted more quickly! This course is intended for scientists and engineers with an interest in developing their skills in writing scientific documents including journal papers, conference proceedings papers, abstracts, reports, theses, and proposals. The course will be of particular interest to researchers and graduate students as well as to university faculty who want to improve both their own writing and that of their students. It will address elements of good writing in science and engineering, including standard practices, terminology and formatting. It will teach attendees how to present information using properly structured sentences, paragraphs, sections, and chapters and how to organize experimental results and analysis in a format suitable for publication in the scientific literature as well as in reports, theses, etc. The topics to be covered include:

- How to communicate your message in clear, precise English;
- How to write effective sentences;
- How to structure paragraphs effectively;
- How to structure documents so that they are clear, effective and easy to read;
- How to be complete but concise;
- Standard writing practices and formatting;
- Effectively presenting your methods, results, discussion, and conclusions;
- Titles, tables, figures, captions and references;
- Standard practices for presenting scientific information;
- Appropriate level of detail;
- Mathematical descriptions, data, and units; and
- Grammar, punctuation, abbreviations, and acronyms.

SHORT COURSE #6

Advanced Microscopy Methods for Studying PEM Fuel Cell Materials

Karren L. More, *Instructor*

The μm - to sub- \AA -scale structural and chemical characterization of fuel cell material constituents via advanced electron microscopy techniques plays an integral role in elucidating the critical material's degradation mechanisms contributing to fuel cell performance loss. Such techniques include atomic-scale imaging via aberration-corrected scanning transmission electron microscopy (STEM) coupled with the ability to resolve compositional/chemical changes at the atomic scale

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using energy dispersive spectroscopy (EDS) and/or electron energy loss spectroscopy (EELS). Recently, the development of specialized holders for conducting novel in situ microscopy experiments (such as liquid STEM, electrochemistry, gas-flow reactions, biasing, etc.) combined with high-resolution imaging and microanalysis has enhanced the ability to study critical structural changes to individual materials constituents comprising fuel cell membrane electrode assemblies under relevant environmental conditions.

The primary microscopy and spectroscopy techniques available today, which are used to study fuel cell materials, will be summarized and described in detail. Advanced methodologies for quantifying critical structural changes related to particular fuel cell testing protocols and materials degradation phenomena will be described and are supported with specific materials-specific characterization studies.

CORPORATE TUTORIAL

Intellectual Property: An Introduction for Research Scientists, Engineers, and Technologists

E. Jennings Taylor, Instructor

This half-day tutorial (1300-1600h) will provide an introduction to the various forms of intellectual property; trade secrets, trademarks, and copyrights with an emphasis on patents. The objective of the tutorial is to provide the electrochemist/engineer with an appreciation of the historical basis of the patent system and the nuances related to the concepts of prior art and obviousness. A case study of the on-going prosecution of an electrochemical technology will be presented. In addition, the Leahy-Smith America Invents Act, signed into law in September 2011, will be reviewed.

This tutorial will provide an introduction to the various forms of intellectual property, trade secrets, trademarks, and copyrights with an emphasis on patents. The foundation of modern patent principles will be traced from their origin in the U.S. Constitution, their early development and recent status. Topics to be covered include:

- Analogies between intellectual property and tangible property;
- Distinction between an author of a scientific paper and inventor on a patent; and
- Statutory criteria for obtaining a U.S. patent:
 - utility,
 - novelty,
 - non-obviousness,
 - enabling description; and
 - lack of prior public disclosure.

The tutorial will provide the basis for determination of novelty vis-à-vis prior art. In addition, the difference between “technical obviousness” and “legal obviousness” will be clarified. Finally,

the nuances regarding public disclosure will be addressed. This tutorial will introduce the various forms of patent claims in view of claim elements and will culminate with case studies of the patent examination process along with the potential for citation analysis as a tool for identifying potential strategic partners. In closing, the purpose of the tutorial is not to replace the patent counsel, but rather to facilitate informed interaction between the scientist/engineer/technologist inventor with said patent counsel.

PROFESSIONAL DEVELOPMENT WORKSHOPS

John R. Susko, Instructor

ECS will sponsor the following three professional development workshops at no extra cost to meeting registrants. All workshops will be held in Columbia, 4th Floor - Union St. Tower, Sheraton.

Writing an Effective Cover Letter and Resume—The need for a cover letter, how to write it, the many “do’s” and “don’ts” in preparing such a letter, and tips for drafting an effective resume.

Sunday 1500-1545h

Monday 1200-1245h

Job Interviewing Tips—How to improve your chances of impressing the interviewer; key questions to ask; and other important pointers for the interviewing process.

Sunday 1600-1645h

Monday 1300-1345h

Resume Round Table—Designed to provide feedback on resumes by publicly critiquing participants’ resumes and offering suggestions on ways to make them more effective. To take full advantage of the workshop, please bring a copy of your current professional resume.

Monday 1400-1700h

ECS CAREER FAIR

ECS is launching our first-ever Career Fair in Seattle. The event will be held in the exhibit hall of the Washington State Convention Center during exhibit hours on Monday, May 7, 2012 from 1800-2000h, and Tuesday, May 8, 2012 from 0900-1400h, and 1800-2000h. The Career Fair is free to all registered meeting attendees and is open to experienced professionals considering a career move and students searching for first-time employment opportunities. ECS Corporate member and nonmember recruiters will be seeking to meet potential employees at every level of experience and will have the ability to post online available positions, review resumes, and conduct interviews prior to and during the meeting.

ECS Presents Its First-Ever Clean Water Technologies Symposium

Don't Miss This Important Full-Day Session!

Water is a critical environmental issue, one of the greatest problems facing the world today. For this vital natural resource to be available through the 21st century, new paradigms are needed for management, remediation, and valuation. With the emergence of novel sensing modalities and processing technologies, ECS has a unique opportunity to provide a forum for the presentation of original research and innovation that can impact the future direction of Clean Water Technologies and provide viable solutions for the current and future needs.

① For more information contact: meetings@electrochem.org

Clean Water Technologies Symposia (A3)

Tuesday May 8, 2012, 0800-1150h & 1400-1720h

Wednesday May 9, 2012, 0830-1110h

Symposium Organizers: B. Stoner, Z. Aguilar, E. Greenbaum, P. M. Natishan, E. J. Taylor, and J. Weidner

- **Water Treatment and Sanitation**
Co-Chairs: Brian Stoner and Elias Greenbaum
- **Water Treatment Technologies**
Co-Chairs: Paul Natishan and E. Jennings Taylor
- **Water Treatment Systems and Applications**
Co-Chairs: Brian Stoner and Paul Natishan
— plus a —
- **Clean Water Technologies Poster Session**

Award Winners

NOTE: For complete biographies of the award recipients, and the schedule of their presentations, please see the General Meeting Program on the ECS website: www.electrochem.org/meetings/biannual/221/221.htm.

Electronics and Photonics Division Award



CHENNUPATI JAGADISH was born and educated in India and worked in India (S.V. College, New Delhi) and Canada (Queen's University, Kingston, Ontario), prior to moving to Australia in 1990. He is currently an Australian Laureate Fellow and Distinguished Professor and Head of Semiconductor Optoelectronics and Nanotechnology Group in the Research School of Physics and Engineering, Australian National

University. He is also Convener of the Australian Nanotechnology Network (more than 1400 members) and Director of Australian National Fabrication Facility, ACT Node. He served as President of the IEEE Nanotechnology Council (NTC) during 2008 and 2009, and Vice-President of IEEE Lasers and Electro-Optics Society during 2006 and 2007. Prof. Jagadish is an Editor of *IEEE Electron Device Letters*, *Progress in Quantum Electronics*, *Journal of Semiconductor Technology*, and *Science*; an Associate Editor of the *Journal of Physics D: Applied Physics*; and serves on editorial boards of 12 other journals. He is an Editor of the Springer Series in Materials Science, the Springer Series in Nano-Optics and Nano-Photonics, and the Semiconductors and Semimetals Book series published by Academic Press/Elsevier.

His research interests include quantum dots, nanowires, quantum dot lasers, quantum dot photodetectors, quantum dot photonic integrated circuits, photonic crystals, plasmonics, photovoltaics, metamaterials, and THz photonics. He has published more than 670 research papers (450 journal papers), eleven invited/review papers, nine book chapters, holds five U.S. patents, co-authored a book, co-edited three books, and edited 12 conference proceedings and six special issues of journals. He won the 2000 IEEE Millennium Medal and received the Distinguished Lecturer awards from IEEE Nanotechnology Council, IEEE Photonics Society, and the IEEE Electron Devices Society. He is a Fellow of ECS, of the Australian Academy of Science, Australian Academy of Technological Sciences and Engineering, IEEE, American Physical Society, Materials Research Society, Optical Society of America, American Vacuum Society, SPIE, American Association for Advancement of Science, Institute of Physics (UK), Institution of Engineering and Technology (UK), the Institute of Nanotechnology (UK), and the Australian Institute of Physics. He received an Australian Federation Fellowship in 2004 and an Australian Laureate Fellowship in 2009 from the Australian Research Council; the Peter Baume Award from the ANU in 2006; the Quantum Device Award from the International Symposium on Compound Semiconductors in 2010; IEEE Photonics Society Distinguished Service Award in 2010; IEEE Nanotechnology Council Distinguished Service Award in 2011; and the 2010 Top Supervisor Award for excellence in research supervision of graduate students from the ANU.

Supramaniam Srinivasan Young Investigator Award of the Energy Technology Division



VIJAY RAMANI is an Associate Professor of Chemical Engineering at Illinois Institute of Technology, Chicago. He also holds an Extraordinary Professorship in Chemical Resource Beneficiation at NorthWest University, Potchefstroom, South Africa. His research interests lie at the confluence of electrochemical engineering and materials science. Current research in his group (six PhD

students, two postdoctoral fellows, one MS, and two undergraduate students) encompasses the synthesis of multi-functional electrolyte and electrode materials for polymer based electrochemical systems, analysis of the source and distribution of overpotentials in electrochemical systems, and mitigation of degradation in electrochemical device components. NSF, ONR, and DOE currently fund his research, with mechanisms including an NSF CAREER award in 2009 and an ONR Young Investigator Award (ONR-YIP) in 2010. He is also the recipient of a 3M Non-tenured Faculty Award (2010). He is currently the Chair of the ECS Industrial Electrochemistry and Electrochemical Engineering Division. Dr. Ramani has a PhD from the University of Connecticut, Storrs (graduate advisors: James M. Fenton and H. Russell Kunz), and a BE from Annamalai University, India, both in chemical engineering.



ADAM Z. WEBER holds BS and MS degrees from Tufts University, the latter under the guidance of Maria Flytzani-Stephanopoulos. Next, he earned his PhD at the University of California, Berkeley in chemical engineering under the guidance of John Newman. His dissertation work focused on the fundamental investigation and mathematical modeling of water management in polymer-electrolyte fuel cells.

Dr. Weber continued his study of water and thermal management in polymer-electrolyte fuel cells at Lawrence Berkeley National Laboratory, where he is now a staff scientist. He also works as a PI in the Joint Center for Artificial Photosynthesis and on redox flow batteries for grid-scale energy storage. He has authored over 30 peer-reviewed articles on fuel cells and related electrochemical devices, developed many widely used models and diagnostics for fuel cells and their components, and has been invited to present his work at various international and national meetings including the Gordon Research Conference on Fuel Cells, the Special Invitation Session at FC Expo 2007, the "lambda" symposium at ECS Boston, and a plenary lecture at the Proton Exchange Membrane Fuel Cells 6 symposium. He has also been the recipient of a number of prestigious awards including a Fulbright scholarship to Australia and the 2008 Oronzio and Niccolò De Nora Foundation Prize on Applied Electrochemistry of the International Society of Electrochemistry. Dr. Weber is also on the Editorial Board of the *Journal of Applied Electrochemistry*.

SES Research Young Investigator Award of the Fullerenes, Nanotubes, and Carbon Nanostructures Division



AURELIO MATEO-ALONSO obtained his BSc (1999) and MSc (2000) degrees in organic chemistry at Universidad Autónoma de Madrid (Spain). In 2003, he completed his PhD at Queen Mary College, University of London (UK), under the supervision of James Utley and Peter Wyatt. Between 2004 and 2009, he worked as a postdoctoral researcher through different placements in the group of Maurizio

Prato at Università di Trieste (Italy). Since 2009, he leads an independent research group at the School of Soft Matter Research of the Freiburg Institute for Advanced Studies (Germany). He has been awarded with the Young Investigator Prize of the Università di Trieste in 2007, the Eugen-Graetz Prize of Universität Freiburg in 2009, and the RSEQ-Sigma-Aldrich of the Spanish Royal Chemical Society (RSEQ) in 2011. His research interests focus on the chemistry and supramolecular chemistry of flat and curved aromatic molecules, such as fullerenes, carbon nanotubes and (aza)acenes, and on their implementation in molecular scale devices and machines, charge transfer dyes, and self-organizing organic/inorganic nanostructures.

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Organic and Biological Electrochemistry Division Manuel M. Baizer Award



DENNIS G. PETERS began his academic career in 1962 at Indiana University, Bloomington; since 1975 he has been the Herman T. Briscoe Professor of Chemistry at that institution. He received a BS degree from the California Institute of Technology in 1958 and a PhD degree from Harvard University in 1962.

Professor Peters has been a member of ECS since 1985. For the ECS Organic and Biological Electrochemistry Division, he has served continuously as a member of its Executive Committee since 1992 and as its Secretary-Treasurer, Vice-Chair, and Chair from 1999-2005. In 2002, he received the Society's Henry B. Linford Award for Distinguished Teaching, and he was elected a Fellow of the Society in 2007.

He has authored 180 research publications, along with five undergraduate textbooks on analytical chemistry. His research has focused on mechanistic and synthetic aspects of the reduction of halogenated organic compounds (alkyl, olefinic, and acetylenic halides), and his research group has used electrogenerated nickel(I) and cobalt(I) complexes as catalysts for the indirect reductive cleavage of halogenated organic species.

Professor Peters has received several national awards for outstanding teaching—the Chemical Manufacturers Association National Catalyst Award (1988), the American Chemical Society Division of Analytical Chemistry Award for Excellence in Teaching (1990), and the James Flack Norris Award for Outstanding Achievement in the Teaching of Chemistry (2001)—as well as 12 teaching awards from Indiana University. From Indiana University, he received the Distinguished Service Award (2005) and the W. George Pinnell Award for Outstanding Service (2006).

Technical Exhibit

The Technical Session coffee break is scheduled for 0930h in the Exhibit area (Ballroom 6E, Level 6, WSCC), on Tuesday and Wednesday to allow meeting attendees additional time to browse through the exhibits. The exhibit will feature instruments, materials, systems, publications, and software of interest to attendees.

Exhibit Hours

Monday, May 7 1800-2000h
includes the Monday Evening Poster Session

Tuesday, May 8 0900-1400h
re-opening 1800-2000h
includes the Tuesday evening Poster Session

Wednesday, May 9 0900-1300h

Exhibitors as of Press-Time

ECS

Booth 205

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2012

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222nd ECS Meeting
2012 Fall Meeting of
The Electrochemical Society of Japan

and with the technical co-sponsoring of the Japan Society
of Applied Physics, the Korean Electrochemical Society, the
Electrochemistry Division of the Royal Australian Chemical Institute,
and the Chinese Society of Electrochemistry.

Future Technical Meetings

2013 Spring Meeting
May 12-17, Toronto, ON, Canada

2013 Fall Meeting
Oct. 27-Nov. 1, San Francisco, CA

2014 Spring Meeting
May 11-16, Orlando, FL

2014 Fall Meeting,
October 5-10, Cancun, Mexico

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Event Highlights

NOTE: For a list of Committee Meetings, please visit the Seattle meeting page: www.electrochem.org/meetings/biannual/221/221.htm.

SUNDAY, MAY 6

- 0900h.....Short Courses
- 1500h.....Writing an Effective Cover Letter and Resume Workshop, Columbia, 4th Floor - Union St. Tower, Sheraton
- 1600h.....Job Interviewing Tips Workshop, Columbia, 4th Floor - Union St. Tower, Sheraton
- 1730h.....ECS Student Mixer
- 1900h.....Electronics and Photonics Division Award Reception and General Meeting, Cedar B, 2nd Floor, Sheraton
- 1930h.....Sunday Evening Get-Together, Grand Ballroom, 2nd Floor, Sheraton

MONDAY, MAY 7

- 0930h.....Technical Session Coffee Break, East & West Lobbies, Level 6, WSCC
- 1200h.....Writing an Effective Cover Letter and Resume Workshop, Columbia, 4th Floor - Union St. Tower, Sheraton
- 1215h.....Industrial Electrochemistry & Electrochemical Engineering Division Luncheon & Business Meeting, Willow A, 2nd Floor, Sheraton (ticket required)
- 1215h.....Physical and Analytical Electrochemistry Division Luncheon & Business Meeting, Willow B, 2nd Floor, Sheraton (ticket required)
- 1300h.....Job Interviewing Tips Workshop, Columbia, 4th Floor - Union St. Tower, Sheraton
- 1400h.....Resume Round Table Workshop, Columbia, 4th Floor - Union St. Tower, Sheraton
- 1400h.....Society Award Lectures, Ballroom 6A, Level 6, WSCC
- 1700h.....The ECS Lecture—"Will It Be a Tank of Lithium to Drive Our Next Car?" by Bruno Scrosati, Ballroom 6A, Level 6, WSCC
- 1800h.....Monday Evening Mixer, Student Poster Session, and Technical Exhibit Opening, Ballroom 6C, Level 6, WSCC
- 1800h.....ECS Career Fair, Ballroom 6C, Level 6, WSCC

TUESDAY, MAY 8

- 0900h.....Technical Exhibit, Ballroom 6C, Level 6, WSCC
- 0900h.....ECS Career Fair, Ballroom 6C, Level 6, WSCC
- 0930h.....Technical Session Coffee Break, Ballroom 6C, Level 6, WSCC
- 1215h.....Annual Society Luncheon & Business Meeting with Student Poster Award Presentation, Cirrus Ballroom, 35th Floor - Pike St. Tower, Sheraton (ticket required)
- 1630h.....ECS Transactions Tutorial Session for Authors, Room 605, Level 6, WSCC
- 1800h.....Technical Exhibit and General Poster Session, Ballroom 6C, Level 6, WSCC
- 1800h.....ECS Career Fair, Ballroom 6C, Level 6, WSCC

WEDNESDAY, MAY 9

- 0900h.....Technical Exhibit, Ballroom 6C, Level 6, WSCC
- 0930h.....Technical Session Coffee Break, Ballroom 6C, Level 6, WSCC
- 1215h.....Dielectric Science & Technology Division Luncheon & Business Meeting, DISCONTINUED
- 1215h.....Energy Technology Division Luncheon & Business Meeting, Willow A, 2nd Floor, Sheraton (ticket required)
- 1215h.....Fullerenes, Nanotubes and Carbon Nanostructures Division Luncheon & Business Meeting, Willow B, 2nd Floor, Sheraton (ticket required)
- 1215h.....Organic & Biological Electrochemistry Division Luncheon & Business Meeting, Cedar B, 2nd Floor, Sheraton (ticket required)
- 1700h.....Manuel M. Baizer Award Reception, Willow A, 2nd Floor, Sheraton (no ticket required)

THURSDAY, MAY 10

- 0930h.....Technical Session Coffee Break, East & West Lobbies, Level 6, WSCC

Hotel & Travel Information

The 221st ECS Meeting will be held at the Sheraton Seattle (1400 Sixth Avenue, Seattle, WA 98101) and the Washington State Convention Center (800 Convention Place, Seattle, WA 98101). We strongly encourage you to stay at the meeting headquarters hotel, the Sheraton Seattle, where your stay will be most enjoyable and convenient. Reservations can be made online from the ECS website at special discounted meeting rate of **\$169**. See the ECS website for more details and to make your reservation.

The deadline for reservations is April 6, 2012. Reservations attempted after April 6 will be accepted on a space and rate availability basis.

Companion Registrant Program—Guests of Technical Registrants are invited to register for the 221st Meeting as a "Companion Registrant." The companion registration fee of \$25 (Early-Bird) or \$30 (after April 6) includes admission to non-ticketed social events, an exclusive lounge with beverage service, Monday through Thursday, 0800-1000h, and a special "Welcome to Seattle" orientation presented by Seattle's Convention and Visitors Bureau on Monday, May 7 at 0900h in the Companion Registrants Lounge.

Please note that online registration is not available for Companion Registrants.

Technical Program

Oral Presentations and Audio-Visual—Oral presentations must be in English. **Laptop computers and LCD projectors will be available in each symposium room for oral presentations. Authors are required to bring their presentation on a USB flashdrive only.** Speakers requiring special equipment must make written request to ECS headquarters (meetings@electrochem.org) no later than three weeks before the meeting, and appropriate arrangements will be made at the expense of the author.

Poster Presentations and Sessions—Poster presentations must be in English, **on a board approximately 3 feet 10 inches high by 3 feet 10 inches wide (1.17 meters high by 1.17 meters wide)**, corresponding to the abstract number and day of presentation in the final program. Please arrive approximately two to four hours before the start of your session to begin setting up your poster displays. Please do not begin setting up your poster until all the poster boards have been numbered. Plan your display to fit on one upright panel approximately 3 feet 10 inches high by 3 feet 10 inches wide (1.17 meters high by 1.17 meters wide). Present displayed information from left to right, starting at the top left of the panel. The paper title, number, names, and affiliations of all authors **MUST** be at the top of the display. The recommended print size for the title is approximately 1" to 2" (2.5 cm to 5 cm) high. Authors should minimize written text but use it when necessary to emphasize essential data and/or to stimulate discussion. All illustrations, drawings, charts, pictures, graphs, figures, and written text should be large enough to allow easy reading from a distance of 5' (1.5 m). Matted and finished photographs are recommended to enhance visibility. Pushpins and/or thumbtacks will be supplied at the meeting. Commercial advertisements or publicity will NOT be permitted in poster presentations. Authors violating this regulation will be asked to remove their presentations immediately. Authors are responsible for setting up their displays, for being present during the entire scheduled poster session, and for removing their displays at the conclusion of the poster session. No posters will be displayed without author participation. **NO EXCEPTIONS WILL BE GRANTED.** Authors are responsible for the security of their displays and all items of value. ECS will not assume any responsibility for lost, stolen, or broken articles. Additional information or special requirements should be addressed to the individual symposium organizers prior to the meeting.

The **GENERAL SOCIETY STUDENT POSTER SESSION** will be held as a part of the Monday Evening Mixer and Technical Exhibit, which features instruments, materials, systems, publications, and software of interest to meeting attendees. All meeting registrants are invited

(continued on page 42)

Symposium Topics and Organizers

Sessions are marked to indicate if they run on Sunday (S), Monday (M), Tuesday (Tu), Wednesday (W), and/or Thursday (Th).

HC Hard-cover (HC) editions of *ECS Transactions* will be available for purchase and pick-up at the meeting; or you may pre-order your hard-cover ECST issue using the meeting registration form in this brochure or when registering online.

e Electronic (PDF) editions of *ECS Transactions* will be available ONLY via the ECS Digital Library (www.ecsdl.org). Electronic editions of the Seattle "at" meeting issues will be available for purchase beginning April 27, 2012. Please visit the ECS website for all issue pricing and ordering information for the electronic editions.

A — General Topics & Tutorials

A0 — Special Lectures (M)

A1 — General Student Poster Session (M) — *V. R. Subramanian, V. Chaitanya, M. P. Foley, and K. B. Sundaram*

A2 — Tutorials in Nanotechnology: More than Moore - Beyond CMOS Emerging Materials and Devices (M) — *D. Misra, S. Datta, and J. Li* **HC e**

A3 — Clean Water Technologies (Tu-W) — *B. Stoner, Z. Aguilar, E. Greenbaum, P. M. Natishan, E. Taylor, and J. Weidner*

A4 — Nanotechnology General Session (M-T) — *F. Chen, O. Leone, and W. Mustain*

B — Batteries, Fuel Cells, and Energy Conversion

B1 — Batteries and Energy Technology Joint General Session (M-Th) — *A. Manthiram, A. Manivannan, and S. Narayan*

B2 — Large Scale Electrical Energy Storage 1 (M-Tu) — *Y. Chiang, C. P. Albarra, W. C. Carter, B. Liaw, J. Meyers, and T. V. Nguyen*

B4 — Ionic and Mixed Conducting Ceramics 8 (M-Th) — *M. Mogensen, T. Armstrong, T. Gur, H. Yokokawa, and X. Zhou* **HC e**

B5 — Special Topics in Battery Science and Technology (M-Th) — *A. Manthiram, B. Liaw, A. Manivannan, and K. Zaghib*

B6 — Tutorials on Electrocatalysis in Low Temperature Fuel Cells (M-Tu) — *T. A. Zawodzinski Jr., S. Mukerjee, and P. Strasser* **HC e**

B7 — Next Generation Portable Power (Tu-W) — *S. Mukerjee, A. Manthiram, and S. Narayan*

C — Biomedical Applications and Organic Electrochemistry

C1 — Organic and Biological Electrochemistry General Poster Session (Tu) — *J. D. Burgess*

C2 — 10th Manual M. Baizer Memorial Symposium on Organic Electrochemistry (M-Tu) — *A. J. Fry and G. T. Cheek*

C3 — Progress in Fundamental and Applied Bioelectrochemistry (W) — *J. F. Rusling*

D — Corrosion, Passivation, and Anodic Films

D1 — Corrosion General Session (Tu-W) — *S. Fujimoto*

E — Dielectric and Semiconductor Materials, Devices, and Processing

E1 — Dielectrics for Nanosystems 5: Materials Science, Processing, Reliability, and Manufacturing (M-W) — *D. Misra, D. Bauza, Z. Chen, T. Chikyow, H. Iwai, and Y. S. Obeng* **HC e**

E2 — Graphene, Ge/III-V, Nanowires, and Emerging Materials for Post-CMOS Applications 4 (M-W) — *Y. S. Obeng, S. De-Gendt, Z. Karim, D. Misra, and P. Srinivasan* **HC e**

E3 — Integrated Optoelectronics 6 (M-W) — *M. Deen, Q. Fang, C. Jagadish, and K. Ohashi*

E4 — Nanoscale Luminescent Materials (M-W) — *P. Mascher and D. Lockwood* **HC e**

E5 — Silicon Compatible Materials, Processes and Technologies for Advanced Integrated Circuits and Emerging Applications 2 (M-Tu) — *F. Roozeboom, E. Gusev, H. Iwai, K. Kakushima, D. Kwong, V. Narayanan, and P. Timans* **HC e**

E6 — Thermal and Plasma CVD of Nanostructures and Their Applications (M-Tu) — *M. K. Sunkara, U. Cvelbar, J. Li, M. Meyyappan, and R. Sankaran*

E7 — Wide-Bandgap Semiconductor Materials and Devices 13 (M-Tu) — *E. Stokes, R. Horng, G. Hunter, Z. Karim, Z. Mi, and C. O'Dwyer* **HC e**

F — Electrochemical / Chemical Deposition and Etching

F1 — Stress-Related Phenomena in Electrochemical Systems 2 (W-Th) — *G. R. Stafford, Y. Cheng, and K. Hebert*

F2 — Surface Treatments for Biomedical Applications 3 (M-Tu) — *S. Djokić, D. C. Hansen, L. Magagnin, L. Nagahara, and Y. Yoon*

G — Electrochemical Synthesis and Engineering

G1 — Industrial Electrochemistry and Electrochemical Engineering General Session (Tu-W) — *J. Weidner*

G3 — Characterization of Porous Materials 5 (Tu) — *J. Staser, J. Fenton, J. Gostick, and V. Sethuram*

G4 — Electrochemical Engineering for the 21st Century 2 (M-Tu) — *V. Subramanian, R. Alkire, L. Deligianni, J. Fenton, J. Harb, and G. Hunter*

G5 — Fuel Cell Membranes, Electrode Binders, and MEA Performance (Tu-Th) — *P. Pintauro*

H — Fullerenes, Nanotubes, and Carbon Nanostructures

H1 — Electron Transfer and Energy Applications of Fullerenes and Nanostructured Materials (M-Tu) — *F. D'Souza, S. Fukuzumi, and D. Guldi*

H2 — Chemistry of Fullerenes and Carbon Nanotubes (Tu) — *N. Martin and J. Nierengarten*

H3 — Carbon Nanotubes and Nanostructures: Fundamental Properties and Processes (Tu-W) — *R. Weisman, S. K. Doorn, and M. Zheng*

H4 — Carbon Nanotubes and Nanostructures: Applications and Devices (M-Tu) — *S. Rotkin, Y. Gogotsi, and R. Martel*

H5 — Endofullerenes and Carbon Nanocapsules (Tu, Th) — *L. Echegoyen, T. Akasaka, and A. L. Balch*

H6 — Carbon Nanotubes and Nanostructures: Medicine and Biology (W-Th) — *T. Da Ros, Z. Aguilar, A. Hirsch, A. Simonian, and L. Wilson*

H7 — Porphyrins and Supramolecular Assemblies (Tu-Th) — *N. Sölladie, K. M. Kadish, and R. Paolesse*

H8 — Nanostructures for Energy Conversion (M-Tu) — *H. Imahori and P. Kamat*

H9 — Chemistry and Physics of Graphene and 2D Nanostructures (Tu-W) — *H. Grebel, R. C. Haddon, and P. Kamat*

I — Physical and Analytical Electrochemistry

I1 — Physical and Analytical Electrochemistry General Session (M-Tu) — *R. Mantz*

I2 — Biological Fuel Cells 5 (M-W) — *S. C. Barton, P. Atanassov, and S. D. Minter*

I4 — Electrocatalysis Applied to Fuel Cells and Electrolyzers (M-Th) — *P. J. Kulesza, S. Fiechter, R. Marassi, and R. Narayan*

I5 — Exploiting Magnets in Electrochemistry (W) — *J. Leddy and I. Fritsch*

I7 — Recent Advances in Spectro-Electrochemistry (M-W) — *A. Wieckowski and S. Mukerjee*

I8 — Electrochemical Impedance Spectroscopy: Modeling and Interpretation (Tu-W) — *P. Vanýsek*

J — Sensors and Displays: Principles, Materials, and Processing

J1 — Sensors, Actuators, and Microsystems General Session (M-Tu) — *M. Carter, Z. Aguilar, B. Ward, and N. Wu*

J2 — Nano/Bio Sensors (M-Tu) — *A. Simonian, Z. Aguilar, B. Chin, J. Li, and L. Nagahara*

J3 — Sensors for Safety and Security (Tu-W) — *E. L. Brosha, M. Carter, B. Chin, J. Li, S. D. Minter, and A. Simonian*

to attend. Formal presentations will begin at 1800h. Students may start setting up their presentations at 1300h; judging of the posters will begin at 1500h. Participants are encouraged to attend the Annual Society Luncheon and Business Meeting on Tuesday at 1215h (ticket required, except for winners) where the winners will be announced and given an award plaque.

AV Tech Table—A Tech Table staffed by audio-visual technicians will be available Sunday through Thursday, for any audio-visual assistance needed for oral presentations.

Speaker Indemnification—The ideas and opinions expressed in the technical sessions, conferences, and any handout materials provided are those of the presenter. They are not those of The Electrochemical Society (ECS), nor can any endorsement by ECS be claimed.

No Recording Allowed—Photographing and/or recording of presentations is NOT PERMITTED unless specifically allowed by the speaker. Anyone making unauthorized photographs or recordings will be asked to leave the session.

Registration & General Meeting Information

Meeting Registration—The meeting registration area will be located in the East Lobby, Level 6, WSCC. Registration will open on Sunday and the technical sessions will be conducted Sunday through Thursday.

Early-Bird Registration—Early-Bird registration is encouraged. Register online at www.electrochem.org, or fax your registration form to 609.737.2743. Attendees prepaying by credit card are encouraged to use our online system, or send the form by fax. If you send a registration by fax, please do not send another copy by mail, as this may result in duplicate charges. **The deadline for Early-Bird registration is April 6, 2012.** Refunds are subject to a 10% processing fee and will only be honored if written requests are received by **April 30, 2012.** **Regular registration rates are in effect online after April 6, 2012 and at the meeting.** All meeting participants are required to pay the appropriate registration fees. Early-Bird and post-April 6 registration payments must be made in U.S. Dollars via Visa, MasterCard, American Express, Discover Card, check, or money order payable to ECS.

Great News about MEETING ABSTRACTS!

ECS is always looking for new ways to make our meeting information more accessible to all attendees and contribute to the sustainability of the planet. So, beginning in Seattle, Meeting Abstracts are always right at hand—and as always, are **FREE**. Registrants may easily access them through wireless Internet which will be available in the Washington State Convention Center, view them on the ECS Meeting App, or download them directly from the ECS website.

Key Locations

Meeting Registration.....	East Lobby, Level 6, WSCC
Information/Message Center	East Lobby, Level 6, WSCC
ECS Headquarters Office	Room 214, Level 2, WSCC
ECS Central	East Lobby, Level 6, WSCC
AV Tech Table.....	Located outside select symposium rooms

Registration and ECS Central Hours

Sunday, May 6	0700-1900h
Monday, May 7	0700-1900h
Tuesday, May 8	0700-1730h
Wednesday, May 9	0800-1600h
Thursday, May 10	0800-1200h

Registration Fees—ALL PARTICIPANTS AND ATTENDEES ARE REQUIRED TO PAY THE APPROPRIATE REGISTRATION FEE LISTED BELOW. Payment can be made by cash, check or travelers' checks in U.S. funds drawn on a U.S. bank. Visa, MasterCard, American Express, or Discover are also accepted.

ECS Member	\$520
Nonmember	\$720
ECS Student Member.....	\$255
Student Nonmember.....	\$295
One Day ECS Member	\$380
One Day Nonmember	\$470
ECS Emeritus or Honorary Member.....	\$0
Companion Registrant.....	\$30

All students must present a current, dated student ID card, or for post-docs, a letter from a professor stating that you are a full or part-time student, when you pick up your registration materials at the meeting. Attendees who wish to have paper copies of abstracts in advance of the meeting should download copies from the ECS website, free of charge.

Financial Assistance—Financial assistance is limited and generally governed by the symposium organizers. Individuals may inquire directly to the symposium organizers of the symposium in which they are presenting their paper to see if funding is available. Individuals requiring an official letter of invitation should write to the ECS headquarters office; such letters will not imply any financial responsibility of ECS.

NEW! Career Fair—ECS is launching our first-ever Career Fair at the Seattle meeting! The event will be held in the ECS Technical Exhibit Hall of the Washington State Convention Center during exhibit hours on Monday, May 7, 2012 from 1800-2000h, and Tuesday, May 8, 2012 from 0900-1400h, and 1800-2000h. The Career Fair is free to all registered meeting attendees. Experienced professionals considering a career move and students searching for first time employment opportunities are encouraged to visit. ECS Corporate member and nonmember recruiters will be available to meet potential employees at every level of experience and will have the ability to post online available positions, review resumes, and conduct interviews prior to and during the meeting.

ADA Accessibility—Special accommodations for disabled attendees will be handled on an individual basis provided that adequate notice is given to the ECS headquarters office.

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