



websites of note

by Zoltan Nagy

Bioelectrochemical systems (BES) for sustainable energy production and product recovery from organic wastes and industrial wastewaters

Bioelectrochemical systems (BESs) are unique systems capable of converting the chemical energy of organic waste including low-strength wastewaters and lignocellulosic biomass into electricity or hydrogen/chemical products in microbial fuel cells (MFCs) or microbial electrolysis cells (MECs) respectively, or other products formed at the cathode by an electrochemical reduction process. As compared to conventional fuel cells, BESs operate under relatively mild conditions, use a wide variety of organic substrates and mostly do not use expensive precious metals as catalysts. The recently discovered use of BESs for product synthesis via microbial electrosynthesis has greatly expanded the horizon for these systems. Newer concepts in application as well as development of alternative materials for electrodes, separators, and catalysts, along with innovative designs have made BESs very promising technologies. This article discusses the recent developments that have been made in BESs so far, with an emphasis on their various applications beyond electricity generation, resulting performances and current limitations.

- Deepak Pant, et al. (Separation & Conversion Technologies, VITO-Flemish Institute for Technological Research, Boeretang 200, 2400 Mol, Belgium)
<http://pubs.rsc.org/en/content/articlelanding/2012/ra/c1ra00839k/unauth#!divAbstract>

Minimizing losses in bio-electrochemical systems: the road to applications

Bioelectrochemical systems (BESs) enable microbial catalysis of electrochemical reactions. Plain electrical power production combined with wastewater treatment by microbial fuel cells (MFCs) has been the primary application purpose for BESs. However, large-scale power production and a high chemical oxygen demand conversion rates must be achieved at a benchmark cost to make MFCs economically competitive in this context. Recently, a number of valuable oxidation or reduction reactions demonstrating the versatility of BESs have been described. Indeed, BESs can produce hydrogen, bring about denitrification, or reductive dehalogenation. Moreover, BESs also appear to be promising in the field of online biosensors. To effectively apply BESs in practice, both biological and electrochemical losses need to be further minimized. At present, the costs of reactor materials have to be decreased, and the volumetric biocatalyst activity in the systems has to be increased substantially. Furthermore, both the ohmic cell resistance and the pH gradients need to be minimized. In this review, these losses and constraints are discussed from an electrochemical viewpoint. Finally, an overview of potential applications and innovative research lines is given for BESs.

- Peter Clauwaert, et al.
<http://link.springer.com/article/10.1007/s00253-008-1522-2#page-1>

Electrochemically assisted microbial production of hydrogen from acetate

Hydrogen production via bacterial fermentation is currently limited to a maximum of 4 moles of hydrogen per mole of glucose, and under these conditions results in a fermentation end product (acetate; 2 mol/mol glucose) that bacteria are unable to further convert to hydrogen. It is shown here that this biochemical barrier can be circumvented by generating hydrogen gas from acetate using a completely anaerobic microbial fuel cell (MFC). By augmenting the electrochemical potential achieved by bacteria in this MFC with an additional voltage of 250 mV or more, it was possible to produce hydrogen at the cathode directly from the oxidized organic matter. More than 90% of the protons and electrons produced by the bacteria from the oxidation of acetate were recovered as hydrogen gas, with an overall Coulombic efficiency (total recovery of electrons from acetate) of 60–78%. This is equivalent to an overall yield of 2.9 mol H₂/mol acetate (assuming 78% Coulombic efficiency and 92% recovery of electrons as hydrogen). This bioelectrochemically assisted microbial system, if combined with hydrogen fermentation that produces 2–3 mol H₂/mol glucose, has the potential to produce ca. 8–9 mol H₂/mol glucose at an energy cost equivalent to 1.2 mol H₂/mol glucose. Production of hydrogen by this anaerobic MFC process is not limited to carbohydrates, as in a fermentation process, as any biodegradable dissolved organic matter can theoretically be used in this process to generate hydrogen from the complete oxidation of organic matter.

- Hong Liu , Stephen Grot, and Bruce E. Logan (Penn State University, University Park, Pennsylvania 16802)
<http://pubs.acs.org/doi/abs/10.1021/es050244p>



About the Author

ZOLTAN NAGY is a semi-retired electrochemist. After 15 years in a variety of electrochemical industrial research, he spent 30 years at Argonne National Laboratory carrying out research on electrode kinetics and surface electrochemistry. Presently he is at the Chemistry Department of the University of North Carolina at Chapel Hill. He welcomes suggestions for entries; send them to nagyz@email.unc.edu.

GLASGOW

ECS Conference on Electrochemical Energy Conversion & Storage with SOFC-XIV

Highlights from the Meeting in Glasgow

The first international ECS Conference on Electrochemical Energy Conversion & Storage with SOFC-XIV convened in Glasgow, July 26-31, 2015, at the Scottish Exhibition and Conference Centre. More than 800 attendees, from over 40 countries explored three main symposium topics. **Subhash Singhal** (Pacific Northwest National Laboratory, U.S.) and **Koichi Eguchi** (Kyoto University, Kyoto, Japan) organized the section on Solid Oxide Fuel Cells, which covered all aspects of research, development, and engineering of solid oxide fuel cells. The section on Batteries was led by **Peter Bruce** (University of Oxford), **Clare Grey** (ALISTORE-European Research Institute), **Stefan Freunberger** (Graz University of Technology, Austria), and **Jie Xiao** (Pacific Northwest National Laboratory, U.S.). The Low Temperature Fuel Cells track, featuring presentations on low-temperature fuel cells, as well as electrolyzers and redox flow cells, was organized by **Hubert Gasteiger** (Technische Universität München, Germany), **Deborah Jones** (CNRS - ICGM - AIME - University of Montpellier, France), **Thomas Schmidt** (Paul Scherrer Institut, Switzerland), and **J. Herranz** (Paul Scherrer Institut, Switzerland).

The ECS Conference on Electrochemical Energy Conversion & Storage with SOFC-XIV served as a major forum for the discussion of interdisciplinary research from around the world through a variety of formats, such as invited and keynote oral presentations, poster sessions, and exhibits. This was the first of a series of planned biennial conferences in Europe by ECS on electrochemical energy conversion/storage materials, concepts, and systems, with the intent to bring together scientists and engineers to discuss both fundamental advances and engineering innovations. The size of the meeting and the focused topical areas allowed attendees to fully participate and listen to a broad range of new topics throughout the week while networking with fellow colleagues and associates.

The conference started off with a general plenary session on Monday morning where **Nigel Brandon**, Director of the Sustainable Gas Institute at Imperial College London, delivered his cutting edge talk, "Electrochemistry in Energy Applications: Policy Drivers, Commercial Opportunities, and Research Challenges." Prof. Brandon addressed the role and value of electrochemical technologies such as fuel cells, lithium batteries, flow batteries, supercapacitors, and electrolyzers in delivering a secure and sustainable energy system. Prof. Brandon is also Director of the UK Hydrogen and Fuel Cells Hub, and Co-Director of the UK Energy Storage Hub.

(continued on next page)



NIGEL BRANDON delivering his plenary address.



From left to right: **NIGEL BRANDON**, Director of the Sustainable Gas Institute at Imperial College, **DANIEL SCHERSON**, ECS President, and **ROQUE CALVO**, ECS Executive Director.



FERGUS EWING, Minister for Business, Energy and Tourism, addressed the audience during the ECS plenary.

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Glasgow Meeting Highlights (continued from previous page)



Attendees gathered together to network, discuss research, catch up with colleagues, and collaborate with new associates during the daily morning and afternoon coffee breaks.

ECS President **Dan Scherson** welcomed **Fergus Ewing**, the Scotland Minister for Energy, Business, and Tourism. Minister Ewing discussed Scotland's renewable energy program and goals while welcoming attendees to Scotland. Minister Ewing explained why Glasgow, Scotland's largest city, is a fitting venue when considering the country's goal of utilizing 100 percent renewable energy by 2020. In 2012, Scotland pulled 40 percent of its power from renewable resources—a 24 percent increase over 2010. Scotland is expected to hit the half-way point on the path of obtaining 100 percent renewable energy this year, making it the perfect platform for some of the top researchers globally in fuel cells and batteries to come together and discuss fundamental advances and engineering innovations that will further enable this transition.

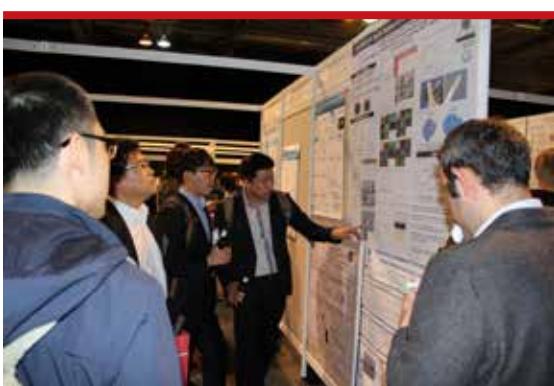
"I am delighted that The Electrochemical Society chose Scotland as the platform for some of the top researchers globally in fuel cells and batteries to come together and discuss advances and engineering innovations," noted Minister Ewing in his introductory address. "Events such as these are a great opportunity to showcase all that Scotland has to offer for both leisure and business and it gave me the opportunity to highlight that Scotland's universities (spearheaded by the Energy Technology Partnership) are at the leading edge of innovation in a broad range of energy storage and conversion technologies. For our part, the Scottish Government and its agencies are working together to open markets, help companies to innovate, make production efficiency savings, and safeguard jobs in order to strengthen the Scottish share of global markets. They are part of a

cultural shift that brings the innovation and creativity of our academic sector to the heart of our business life and puts business drive firmly into the heart of our academic sector."

More than 400 oral presentations and 300 poster presentations added great depth to the scientific material presented in Glasgow.

The Low Temperature Fuel Cells symposium selected four student poster award winners; the awards were sponsored by Ion Power. First place was awarded to Susan Taylor, Paul Scherrer Institute (Switzerland), for her poster entitled, "Oxygen Functionalized Carbon Surfaces — A Suitable Electrode Material for Vanadium Reduction in Redox Flow Cell Applications." Second place was awarded to Jarrod Milshtein, Massachusetts Institute of Technology (U.S.), for his poster entitled, "Analytical Model for the Interdigitated Flow Field." Third place was awarded to Zakiya Al Amri, School of Physics, University of Bristol (UK), for her poster entitled, "The Catalytic Behavior of Pt Clusters on Au and Pd/Au as a Function of Their Surface Coverage and Density." Also in third place was Ludwig Asen, Technische Universität München (Germany), for his poster entitled, "Electrodeposition of Novel Catalyst Materials for the Oxygen Reduction Reaction."

ECS thanks all the presenters, exhibitors, and volunteers for their support in making the ECS Conference on Electrochemical Energy Conversion & Storage with SOFC-XIV a huge success. A special thanks to the meeting sponsors, Pine Research Instrumentation, Ion Power, and Metrohm U.K. Ltd. ■



Attendees enjoyed the week-long poster and technical exhibit sessions in the afternoons and evening. With over 300 posters and 20 exhibitors, this offered the perfect platform to socialize over refreshments while browsing unbeatable content and visiting with exhibitors to learn about their newest products.

SOCIETY NEWS



The Low Temperature Fuel Cell student poster award winners with the Low Temperature Fuel Cell lead and co-organizers. From left to right: THOMAS SCHMIDT, MIKE PERRY, JARROD MILSSTEIN, SUSAN TAYLOR, LUDWIG ASEN, ZAKIYA AL AMRI, DEBORAH JONES, JUAN SALANER HERRANZ, and HUBERT GASTEIGER.



Attendees lining up to participate in the whiskey and haggis tasting at the welcome reception hosted by Arisaig Restaurant in Glasgow.



A bagpiper welcomes guests to the SOFC banquet held on Wednesday evening at the Glasgow Science Centre.



In the **NEXT** *issue of*
INTERFACE

- The winter 2015 issue of *Interface* will feature the **Luminescence and Display Materials Division** of ECS. The issue will be guest edited by **Uwe Happek** from the University of Georgia and **Anant Setlur** from the GE Global Research Center, and will feature the following technical articles: “Impact of Light Emitting Diode (LED) Adoption on Rare Earth Element Use in Lighting,” by **A. Y. Ku, A. A. Setlur, and J. Loudis**; “Polymeric Materials in Phosphor-Converted LEDs for Lighting Applications: Outlook and Challenges,” by **M. Tchoul, A. Piquette, and A. Linkov**; “Phosphors-by-Design: Computational Approaches Toward Advanced Luminescent Materials,” by **J. Brgoch**.
- Highlights from the **228th ECS Meeting in Phoenix** will be presented, including news and photos from the Electrochemical Energy Summit (E2S), the general and student poster sessions, and the get-togethers.
- Biographical sketches and candidacy statements of the nominated candidates for the annual election of officers for ECS.
- **Tech Highlights** continues to provide readers with free access to some of the most interesting papers published in the ECS journals.
- The **2015 ECS Summer Fellowship Reports** including reports from the recipients of the 2015 Edward G. Weston Summer Research Fellowship, the 2015 Colin G. Fink Summer Research Fellowship, the 2015 Joseph W. Richards Summer Research Fellowship, the 2015 F. M. Becket Summer Research Fellowship, and the 2015 H. H. Uhlig Summer Research Fellowship.

ECS Staff News



CASEY EMILIUs joined ECS in January 2015 as the Meetings Coordinator. As the Meetings Coordinator, she is responsible for the development, organization, and execution of the Society's meetings logistics. This includes handling all on- and off-site logistics including the hotel blocks, catering menus, and non-technical scheduling. She also works very closely with the Society's Divisions and Sections to ensure that their time at the biannual meetings is both productive and enjoyable. Casey graduated from Monmouth University in 2011 with a Bachelor of Science degree in Business Marketing and a minor in Information Technology. She has been involved in the event planning industry for 10 years with her passion stemming from her mother, who owned an event planning business. Shortly after graduating, she took a position working as the office manager at one of the top rated restaurants in New Jersey. Just a few months after taking that position she was promoted to event manager. After spending two and a half years on the vendor side of the event planning industry, Casey joined ECS where she is flourishing within her position and proving to be a valuable addition to the staff.



AMANDA STALLER joined ECS in August 2014 as the Marketing Communications Assistant. In this role, Amanda is responsible for helping build ECS's online presence through the creation and use of the ECS Redcat blog (www.ecsblog.org), newsletters, podcasts, videos, and social networking tools. Additionally, Amanda works to grow the Society's exposure worldwide through online marketing campaigns and outreach to the news media.

In 2012, Amanda graduated from La Salle University in Philadelphia, PA with a BA in Communication. Prior to joining ECS, Amanda gained valuable experience in writing and digital outreach at WHYY's Newsworks and various hyperlocal papers in the Philadelphia area. She has covered topics ranging from climate change to food security, taking special interest in advocacy issues. She has also worked with *Magnet* magazine, where she explored local music culture and developed new marketing initiatives.

"Amanda is helping the Society and our members tell their stories," says Rob Gerth, Director of Marketing & Digital Engagement. "Through her interviews and new media, she's able to reveal the relevance of our science and humanity of our scientists." ■

Institutional Member **spot**light Gamry



From webinars to short courses, Gamry Instruments has a passion for educating users about electrochemistry. “We are a bunch of scientists and engineers who enjoy seeing our instruments used in creative ways,” notes Chris Beasley, Gamry Marketing Manager. To facilitate that creativity, Gamry participates in several short courses throughout the year, including the Penn State Corrosion Short Course, the Electrochemical Impedance Spectroscopy Course in Houston, and the Case Western Short Course on Electrochemistry. They also host webinars and will be conducting a workshop at the upcoming 228th ECS Meeting in Phoenix, AZ.

In addition to their hands-on education opportunities, Gamry also maintains a comprehensive library of application notes, technical support articles, and videos on their website. Free and open to all,

Gamry’s web resources complement their high-quality customer support and help instrument users learn more about electrochemistry and electrochemical techniques for research.

Gamry joined ECS as an institutional member in 2007. It has been a genuine pleasure working with them over the years as an institutional member, advertiser, and exhibitor. Their innovative spirit, knowledge, and commitment to electrochemistry make them a great partner.

“We are pleased to work alongside ECS to bring electrochemistry to a larger audience,” comments Dr. Beasley. “Electrochemistry and the application of electrochemical technologies play a crucial role in our everyday lives without the overwhelming majority of the public even realizing it. This is a very exciting time to be involved in the electrochemistry arena, and we can’t think of a better partner to be working with toward the lofty goal of educating the public about the importance of electrochemical technologies.” ■

INTERFACE

Never in ECS history have we experienced this level of interest and importance in electrochemical and solid state science and technology programs. It's a great time to be in



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ecstransactions

Volume 68—Glasgow, Scotland

from the ECS Glasgow meeting, July 26-July 31, 2015

The following issues of *ECS Transactions* are from symposia held during the Glasgow meeting. All issues will be available in electronic (PDF) editions, which may be purchased by visiting <http://ecSDL.org/ECST/>. Some issues may also be available in CD-ROM editions. Please visit the ECS website for all issue pricing and ordering information. (All prices are in U.S. dollars; M = ECS member price; NM = nonmember price.)

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Vol. 68 Solid Oxide Fuel Cells XIV (SOFC-XIV)

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Editors: Jones, Schmidt, Herranz, Gasteiger	
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Email: orders@electrochem.org

05/06/15

Five Questions for Scott Lillard



SCOTT LILLARD is currently the Professor & Carbone Endowed Chair in Corrosion at the University of Akron, where he leads academic research and is a major contributor to the establishment of the university's new Corrosion Engineering program. He has recently been appointed to the ECS Electrochemical Science & Technology (EST) Editorial Board as an Associate Editor for a two-year term beginning July 1, concentrating in the Corrosion Science and Technology Technical Interest Area.

What do you hope to accomplish in your new role as an EST Editorial Board Associate Editor?

I have some experience working on the board of some other journals, but I don't think that's what I really contribute. What I contribute is this idea of customer service. There are a number of reasons why people publish in the journal. It might be the appropriateness of the content or the impact factor, but the third reason is probably customer service. What does that mean? That means getting good peer-reviews in a timely manner and treating the authors in a professional manner.

How do you think peer-reviewed journals have changed over the years?

I think the goals of authors are the same as they were 20 years ago. They want to get their publication out to people in their field so they can read it. They want to do that in as timely a manner as possible. The way in which the process is expected to occur is much different now than it was 20 years ago. It would take you six or nine months to get reviews back. That's just not expected anymore. Everything is expected to be much more efficient now. I think efficiency, speed, and customer service are the things that are changing.

What led to your interest in corrosion engineering?

I did my undergraduate work in chemistry. I think I've always been—even when I was in high school—interested in science. I didn't really know what I wanted to do after my undergraduate work, and I went to work at the Johns Hopkins University Applied Physics Laboratory. That's when I really first got interested in academic research. I enjoyed the project I was working on there. I liked it from a technical aspect; it seemed like it was a good fit for what I liked about chemistry. It was corrosion related and I liked electrochemistry, even as an undergraduate. It kind of went from there. I went back to graduate school and it just kind of snowballed from there.

What kind of research are you currently working on?

All of my research is pretty academic, but it does have applied applications in the real world. I'm working on projects with the U.S. Department of Defense. Each project has a very specific application. For example, the alternating current project I'm working on deals with buried pipelines. The gas transmission pipelines that distribute natural gas or liquid petroleum throughout the United States are usually in what are called "shared right-of-ways" with power lines. There is some loss of that AC current from the transmission power line to the buried gas pipeline that's below it. That AC current that's running on the pipeline increases corrosion rates. If you have a buried gas pipeline, the last thing you want is increased corrosion rates—a failure that might be catastrophic in a residential or commercial area where you can have loss of lives.

Are students interested in corrosion engineering?

Yes, absolutely. When I got here, the first class that was enrolled was eight students. This fall, we have 40 students enrolled in the program. Overall between freshmen and seniors, we have 80 or 100 students enrolled in the program. I think there's a lot of excitement from students, and we have more companies that want our students for those co-op programs than we have students to supply.

2015 Sponsored Meetings

In addition to the regular ECS biannual meetings and ECS Satellite Conferences, ECS, its Divisions, and Sections sponsor meetings and symposia of interest to the technical audience ECS serves. The following is a list of the sponsored meetings for 2015. Please visit the ECS website for a list of all sponsored meetings.

- **10th Simposio en Ciencia de Materiales Avanzados y Nanotecnología (Advanced Materials Science and Nanotechnology Symposium, SCiMAN)**, December 7-9, 2015 — San Jose, Costa Rica
- **66th Annual Meeting of the International Society of Electrochemistry**, October 4-9, 2015 — Taipei, Taiwan
- **16th International Conference on Advanced Batteries, Accumulators and Fuel Cells**, August 30-September 4, 2015 — Brno, Czech Republic

To learn more about what an ECS sponsorship could do for your meeting, including information on publishing proceeding volumes for sponsored meetings, or to request an ECS sponsorship of your technical event, please contact ecs@electrochem.org.

New Division Officer Slates

New officers for the fall 2015–fall 2017 term have been nominated for the following Divisions. All election results will be reported in the winter 2015 issue of *Interface*.



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