ISMET news

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QUARTERLY NEWSLETTER

ALWAYS MOVING FORWARD

Our field is maturing with new research groups

Dear ISMET member,

I am writing this editorial surrounded by boxes in my new apartment in Germany. As you may know, my lab is moving from Cornell University to the University of Tübingen in Southern Germany. In this newsletter you will find a reoccurring focus item for new faculty in which the start or move of labs is being advertised, so that you can keep track of all the changes in the research field of microbial electrochemistry. By the way, ISMET is also always changing. From the start of ISMET, a grass-roots organization was envisioned with a fast revolving board membership to prevent the same people from running the organization.

Here, I am presenting the new board members to you. I want to first thank the leaving board members, which are Federico Aulenta, Stefano Freguia, and Daniel Bond for serving on the board. All of them will remain active within ISMET as conference organizers or committee chairs/members. The new board members are: Annemiek ter Heijne, Benardino Virdis, and César Torres. Below in this newsletter an introduction to each is shown. Thanks to all for willing to serve and to volunteer time.

This will be a busy Fall with three regional meetings: 1) AP-ISMET meeting in Busan, South Korea from Aug. 31-Sept. 1; 2) EU-ISMET meeting in Rome, Italy from Sept. 28-30; and 3) NA-ISMET meeting in Palo Alto, in the USA from Oct. 5-7. You can follow this interest via our twitter feed at the ISMET website – please follow! The continued interest shows that our field is maturing with new research groups finding important research questions to address. One of the focus areas that is currently stimulating this interest is through upgrading CO_2 into useful products at biocathodes. This focus area of microbial electrosynthesis is quickly evolving and has resulted in both winners of the 2016 Innovation Award for Best Technological Advancement and 2016 Discovery Award for Best Scientific Paper: Sylvia Gildemyn (supervised by Korneel Rabaey) and Ludovic Jourdin (supervised by Stefano Freguia), respectively. See more information below in this newsletter. The recipients will receive plaques at the EU-ISMET and AP-ISMET meetings.

I hope to see many of you soon at the EU- and NA-ISMET meetings.

Lars.

ISMET
international society for microbial electrochemistry and technology

In this issue

Announcements ::

NEW ISMET BOARD MEMBERS

Dr. Bernardino Virdis is a Research Fellow at the Advanced Water Management Centre and its affiliated Centre for Microbial Electrochemical Systems at The University of Queensland, Australia. He also lectures Environmental Engineering at the School of Chemical Engineering at UQ. Bernardino has 10 years experience in microbial electrochemistry research. His PhD dissertation (UQ, 2010) on bioelectrochemical reduction of nitrogen oxides and oxyanions earned him the Dean's Award for Outstanding PhD theses. His current research and projects focus on understanding long range and interfacial electron transport in microbial bio films using a combination of electrochemical and spectroscopy techniques, bioelectrochemical wastewater treatment, nutrients recovery, bioremediation, materials development for bioelectronics applications, production of biofuels and commodity chemicals through electrosynthesis and electrofermentation.

Annemiek ter Heijne is an assistant professor at the Sub-department of Environmental Technology at Wageningen University. She obtained her PhD degree at the same university in cooperation with Wetsus, Centre of Excellence for Sustainable Water Technology. In her current position, she combines teaching in the field of renewable energy from a thermodynamic perspective with research on microbial electrochemical technologies. Her current projects focus on metal recovery, ammonium recovery, capacitive bio-anodes for wastewater treatment, and the conversion of electricity and CO_2 into methane. Two years ago, ter Heijne was awarded the prestigious Dutch VENI grant, in which she studied the use of capacitive granules as bio-anodes for electricity generation from wastewater.

César I. Torres is an associate professor within the chemical engineering program at Arizona State University and part of the Swette Center for Environmental Biotechnology (SCEB) and the Center for Bio-mediated and Bio-inspired Geotechnics (CBBG). He has been working in editothe field of microbial electrochemistry since 2003; his Ph.D. focused on microbial kinetics of anode-respiring bacteria. Current projects in his lab focus on characterizing transport processes in microbial electrochemical technologies (METs), identifying new microbes capable of anode respiration, and optimizing reactor design for typical MET applications. Torres already served on the ISMET board for two years right after its inception and is currently the editor for ISMET News.

Awards 2016

Ludovic Jourdin

This year the ISMET awards committee has received five nominations for the Discovery Award and three nominations for the Innovation Award. These papers have been independently assessed by experts from the ISMET community (seven and six referees have graded the papers for the Discovery and the Innovation Awards respectively). The outcome of their assessment can now be released and we are pleased to announce the winners of the awards.

The 2016 Discovery Award for Best Scientific Paper goes to Ludovic Jourdin supervised by Stefano Freguia for his paper published this year in ChemElectroChem and entitled "Biologically Induced Hydrogen Production Drives High Rate/High Efficiency Microbial Electrosynthesis of Acetate from Carbon Dioxide" (DOI: 10.1002/celc.201500530).

The 2016 Innovation Award for Best Technological Advancement goes to Sylvia Gildemyn supervised by Korneel Rabaey for her paper published last year in Environmental Science & Technology Letters and entitled "Integrated Production, Extraction, and Concentration of Acetic Acid from CO_2 through Microbial Electrosynthesis" (DOI: 10.1021/acs.estlett.5b00212)

Both of this year winner's contributions lead the way toward the decrease of carbon dioxide level in the atmosphere through its use as a feedstock in bioelectrosynthesis.

Congratulations to the winners and their supervisors!

…And let's hope that the vinegar market does not crash after these breakthroughs.

Frédéric Barrière

Interview with Ludovic Jourdin

What is your background (undergraduate, graduate) and how long have you been in your current position?
After completing my Bachelor of Science in Chemistry in 2008, I was awarded an Honour's Master degree in Chemical Engineering in 2011 by the National Graduate School of Chemistry –University of Montpellier in France. I then carried out my PhD at the Advanced Water Management Centre, The University of Queensland, Australia, under the supervision of Prof Jurg Keller and Dr Stefano Freguia. I obtained my PhD in August 2015, on the topic of microbial electrosynthesis from carbon dioxide. From July 2015, I moved to Wageningen University to pursue a Post-Doc at the Sub -Department of Environmental Technology, with Prof Cees Buisman and Assistant Prof David Strik.

Describe briefly your project.
My PhD research aimed at developing new approaches to enhance performance of microbial electrosynthesis from CO_2 while shedding lights on some of the process mechanisms. Performance enhancement was enabled through the development and combination of a well acclimatized and enriched microbial culture, coupled with the use of newly synthesized three-dimensional hierarchical electrode materials, comprised of flexible multi-walled carbon nanotubes on reticulated vitreous carbon.

What was the progress within your lab that led to this idea?
A more in-depth understanding of the MES process is of high importance, not only for fundamental knowledge but also for the actual technology practical implementation. Therefore, we came up with the idea to combine a wide range of powerful tools in our labs to elucidate the electron flows from the cathode to the terminal electron acceptor, CO_2, in our MES reactors. The use of a titration and off-gas analysis (TOGA) sensor in combination with electrochemical tests allowed us to demonstrate that the main electron transfer mechanism occurs through H_2, without H_2 able to escape from the biofilm, and leads to a high microbial electrosynthesis rate of acetate and high selectivity. Scanning electron microscopy, energy-dispersive X-ray spectroscopy, fluorescent in situ hybridization – Raman spectroscopy, and microbial community analysis demonstrated that this high H_2 production rate was biologically induced, likely through the biological modification of the electrode surface with metal copper (nano) particles.

How do you see this project benefiting the MET community?
This project highlights some fundamental mechanisms but also indicates a possible direction to take towards high volumetric MES rates, selectivity and efficiency. I hope all the findings presented in this work can benefit the MET community to further their own research on this topic and other bio-cathode processes, create novel ideas and concept, and help advance the technology towards its practical implementation.

What are the future plans related to this research?
Much more can be done on this hot topic! For example, one question is, what is limiting this MES process and what can be done to tackle this and improve even further the performance. Another question is, can higher value chemicals than acetate be produced and how? Several strategies are under investigation and I am looking forward to the results and to see what other researchers come up with in the near future. Many more exciting questions remain.

What are your future career plans? Are you planning to continue research in METs? Any other topics you are interested in researching/working with?
My career plan is to stay in academia to continue my research on novel microbial electrochemical technologies as well as broaden my horizon towards other topics, such as material science, microbiology, products extraction, and other biotechnology processes.

Sylvia Gildemyn

Interview with Sylvia Gildemyn

What is your background (undergraduate, graduate) and how long have you been in your current position?
In 2007 I started a Bachelor of Bioscience Engineering at Ghent University, in Belgium. I subsequently did my Masters in Bioscience Engineering at Ghent University, and graduated with a major in Environmental Technology in 2012. For my graduation research project, I worked in the lab of Prof Korneel Rabaey on anaerobic digestion. As I was greatly interested in research, and was intrigued by new possibilities with biocathodic processes, I applied for a PhD grant. The grant was awarded and in October 2012 I started working on microbial electrosynthesis, under the supervision of Prof Korneel Rabaey.

Describe briefly your project.
I have been working on the development of a reactor technology platform for microbial electrosynthesis. The core idea is that the applied current is not only a source of electrons for acetic acid production, but also leads to transport of charged molecules over a membrane, as a result of charge balancing. The produced acetic acid can thus be transported over an anion exchange membrane, as acetate. The project focused on reactor engineering, bringing together all aspects (microbial culture, reactor design, operational parameters) to obtain a lab-scale demonstration reactor.

What was the progress within your lab that led to this idea?
In 2012, when I started my PhD research project, there were only very few publications on microbial electrosynthesis. In the lab, we had started work on membrane electrolysis, which is the use of an electrochemical systems with anion exchange membranes to extract short and medium chain carboxylic acids directly from fermentation broths. The acidified extracted product could then be further converted to added value chemicals. We had the idea to apply the same principle to directly extract cathodically produced acetate from microbial electrosynthesis reactors.

How do you see this project benefiting the MET community?
I think it's important to look further than the lab. Microbial electrosynthesis has a lot of potential, but how are we going to move from an idea ("let's use bugs and electricity to convert CO_2 to acetic acid"), to a process that we can implement at larger scale? We like to tackle these questions from the beginning, by thinking about applications from the start. It changes the way you design a study.

What are the future plans related to this research?
We need to move from a proof-of-concept to larger scale. The focus will be on increasing production rates, and increasing the reactor size. With these insights we can evaluate the reactor design. Also, we see the electrochemical extraction and membrane electrolysis as an interesting tool to assist and steer fermentation processes.

What are your future career plans?
In October 2016 I will obtain my PhD degree. Microbial electrosynthesis is booming, and there is still a lot of research to do before we can move on to pilot scale applications. During the 6 months I spent at Cornell University in Prof Lars Angenent's Laboratory, last year, I worked on fermentations and it was great to learn so many new things by working on a different topic. It is been a hard choice between continuing research as a postdoc, or leaving academics for a job in industry, to work on more applied environmental engineering. I have recently been offered the opportunity to work as a researcher in a company, on gas fermentations and waste fermentation processes. It looks like the perfect way to combine the best of both worlds!

Author:

Frédéric Barrière

Teen researcher ::

HIGH SCHOOL STUDENT AUSTIN WANG WINS TOP PRIZE ON MFC PROJECT

Austin Wang

Mr. Austin Wang is a high school student that has worked on microbial electrochemistry for several years. Through the evolution of his project, Mr. Wang has performed enrichments, metagenomics analyses, and used E. coli as host for genes associated with anode respiration. His final project, titled Boosting MFC Biocatalyst Performance: A Novel Gene Identification and Consortia Engineering Approach, won the top prize at the Intel International Science and Engineering Fair in Phoenix, Arizona. He earned US$75,000 from this prize. After the event, Mr. Wang stopped by Arizona State University, where we had a chance to talk about the future of MET research and his future aspirations as a young researcher.

Explain briefly how did you get involved in MET research, where did you hear about this?

In our grade 8 science class we were required to conduct an independent research project and I decided to build a mini hydrogen fuel cell car. The following year, I was reading some articles online when I found out that bacteria could also generate electricity in a fuel cell, and I thought that was insanely cool. I have been involved with MFCs ever since.

How long was the research and what was the progress/evolution of the research to reach to the Intel Science Fair?

The research began in grade 9 when I decided to fill an empty cashew container with two sheets of graphite and soil from my backyard. I noticed that the power output was increasing over time, so the following year I did some metagenomic analysis on how the bacterial community on the anode was changing over time. This led me to wonder what kinds of mechanisms or features caused certain bacteria types to be favoured over others. I started using E. coli hosts to look at the genes that were being enriched in the MFCs, and some of those findings helped propel me to the Intel International Science and Engineering Fair.

What are your futures plans? What area of research do you want to do in the future as an undergraduate?

I am not too sure where I want to head from there, but my experiences working with MFCs have taught me that I want to pursue something that is at the nexus of many diverse fields, and has the potential to make a positive impact on communities around the world.

Author:

César I. Torres

Appointments ::

This section of ISMET News will feature faculty and research managers as well as existing ones that recently moved to a new appointment. This section will be presented once a year in the September issue. Enjoy!

Dr. Lars Angenent

has joined the Center of Applied Geosciences (ZAG) at the University of Tübingen in Germany at the rank of Full Professor in Environmental Biotechnology. He has spent the last eight years in the Department of Biological and Environmental Engineering at Cornell University at the rank of Full and Associate Professor after 6 years on the faculty at Washington University in St. Louis as an Assistant Professor. Lars holds a Ph.D. in Environmental Engineering from Iowa State University, an M.S. in Environmental Technology/Microbiology from Wageningen University, Wageningen, The Netherlands, and a B.S. in Environmental Sciences from Wageningen University. At ZAG he will closely collaborate with Prof. Andreas Kappler on microbial electrochemistry in soils. Lars will continue to work with microbial electrochemical technologies, but he will also focus on C1 biocatalysis such as syngas fermentation and methanogenesis. In addition, he will continue working with reactor microbiomes (open cultures) to elongate short-chain carboxylic acids into medium-chain carboxylic acids. Dr. Angenent also remains to be president of the ISMET.

Dr. Sudeep Popat

joined the Department of Environmental Engineering and Earth Sciences at Clemson University this Fall, after spending six years at Arizona State University. At ASU, Dr. Popat worked with Dr. César Torres on several aspects of microbial electrochemistry technologies, spanning from fundamental research to applied projects. Dr. Popat's work on cathodic limitations in microbial electrochemical cells garnered significant interest and attention, including best discovery and best presentation awards from ISMET in 2012. Dr. Popat has been a co-investigator on three ONR grants and one NSF grant during his time at ASU, and also served as project manager for a DoD-DoE SERDP grant awarded to Dr. Torres. Dr. Popat holds a Ph.D. in Chemical and Environmental Engineering from the University of California, Riverside, where he worked on the areas of gas-phase bioreactors and reductive dehalogenation of trichloroethene, and a BE in Chemical Engineering from Sardar Patel University, India. At Clemson, he will continue working on microbial electrochemistry technologies, as well as expand into emerging areas such as anaerobic membrane bioreactors and algal wastewater treatment.

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