

# ISMET news

Quarterly newsletter

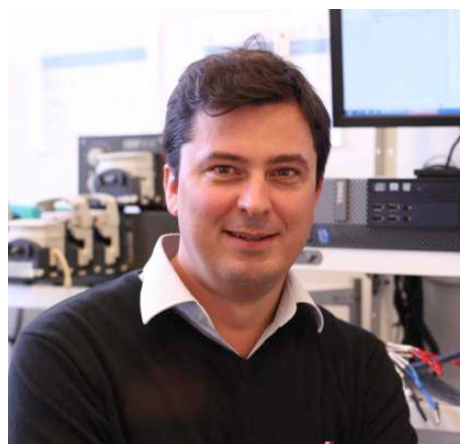
No. 6 – Dec 2014

## The bigger picture

The translation to practice is the key challenge to overcome if we want to sustain research at the present level

Dear ISMET member,

I was recently reading the feature article [<http://www.sciencemag.org/content/346/6215/1284.full>] in *Science* by Robert Service on how the conductive nature of DNA is used by cells to detect damage and direct repair mechanisms. Electricity is truly everywhere in nature and from our field we can contribute so much! A solid understanding of electrochemical principles by microbiologists and engineers working with living matter provides an unusual viewpoint on what happens at cellular as well as reactor level. While we are learning much about the functioning of our microbial world, the translation to practice is the key challenge to overcome if we want to sustain research at the present level. As an example, microbial electrosynthesis attracts much attention at the moment as it enables using intermittent power for CO<sub>2</sub> capture and conversion. However, full-scale plants are still many years away, not just because of the present lack of knowledge, but also because the end user is sitting on the fence. While large companies sustaining major CO<sub>2</sub> emissions realise an emissions problem is coming, it is yet a too big and too much undefined problem in terms of cost and reduction levels to provide an incentive for investing strongly and structurally in novel developments beyond carbon storage. The key driver may be the market: produce products in demand from CO<sub>2</sub> and the supply will follow. A possibly revised (downward!) outlook on available shale gas may help too... So next time, look in your Sigma or Merck catalogue with different eyes: Can I maybe make this compound with microbial electrochemical technology?



With that note, I wish you an excellent end of year and look forward to seeing you at the latest at ISMET2015 in Arizona!

Sincerely,



*Korneel Rabaey*

*President*

*Feedback: [Korneel.rabaey@ugent.be](mailto:Korneel.rabaey@ugent.be)*

# EU-ISMET 2014: view from the cloister

About 120 scientific contributions and 40 oral presentations showed up the results from young researchers in the field in a lively meeting

The regional EU-ISMET conference registered 120 scientific contributions distributed among six different sessions and a poster exhibition in a centenary cloister. Indeed, about 40 oral presentations (including pitches) made this meeting the perfect scenario for showing the results and discoveries from young researchers.

Prof. Korneel Rabaey, President of ISMET, was the keynote speaker with an interesting lecture about the current state of microbial electrosynthesis. Furthermore, invited speakers from the three regional sections, EU, NA and AP, lectured the latest mechanistic insights on the microbial electron transfer, the latest wastewater applications from pollutant removal to resources recovery, the most innovative applications in natural environments or recent advances in system design and architecture.

The award for the *Best Oral Presentation* went to Erick Bosire (Aachen, Germany) while Sylvia Gildemyn (Ghent, Belgium) was awarded for *Best Pitch*. Moreover, the company Aqualia awarded Anna Vilajeliu-Pons (Girona, Spain) and Anthonella Marone (Narbonne, France) for *Best Communication on MET Applied to Water*, while the start-up company Nanoelectra awarded Carolina Cruz Viggì (Rome, Italy) for *Best Communication on MET Applied to the Environment*.

One of the mosts emotive moments of the conference was the planting of a maple tree to offset the carbon conference footprint. However, by the conference dinner we realized that our maple would roughly take up the CO<sub>2</sub> emissions from our colleague Cesar Torres flying from Arizona so we came up with the idea of planting 80 additional trees to offset ca. 65 tons of CO<sub>2</sub> estimated to be released by our delegates (flights, train, appliances) during the event. The Royal Botanical Garden of Alcalá, placed at the External Campus of the University of Alcalá seemed to be the ideal location for hosting them and making EU-ISMET a CO<sub>2</sub>-free organization. So travel to the next ISMET meeting with the guarantee of an environmental sustainable organization. Let's keep planting!

Abraham Esteve-Núñez, Chair EU-ISMET 2014



## Is soil bioremediation the 'new underground culture'?

I reached the 2<sup>nd</sup> European meeting of the International Society for Microbial Electrochemistry and Technologies (ISMET) from my voluntary exile in the Bavarian labs. Originally I belong to the Bioelectrogenesis Group from the University of Alcalá but given the distance I haven't been an active part of the congress organisation. Anyway, before long the congress brought me into a two days of captivating performances: acetate bioproduction, *Escherichia coli* and electrodes, young researchers meeting for the first time, fluidized bed electrodes, bioelectrochemical metal recovery and reduction of CO<sub>2</sub>, people dancing "aphex twin" on Thursday night (that's not true, but cool) and of course many organisms of every kind totally in the mood.

The catatonic trip finished on Friday afternoon and a

simple question was always in my mind: *Is soil bioremediation the 'new underground culture'?* Cool, trendy, nice to talk about having a coffee but never on the cover of the magazine. One oral presentation about contaminated marine sediments, one pitch communication about polluted soil and three posters. That's all?! Financial reasons? Moderate social impact regarding to waste water treatments? Bioelectrogenesis labs far away from soil departments? Which are the reasons?

Let's see if the production around this topic increases in Rome 2016. There, I am sure we will have again a fantastic and profitable time with or without soil bioremediation, as we did in Alcalá. Best regards to everyone.

Jose Rodrigo Quejigo, PhD student  
University of Alcalá

# An inspiring conference

The 2<sup>nd</sup> European Meeting held in Alcalá de Henares, on 3-5 September was marked not only by the heat but also by the hot topics on METs field

The University of Alcalá invited researchers from all over the world to the 2<sup>nd</sup> EU-ISMET meeting nearby the Spanish capital Madrid. Together with the IMDEA Water Institute they organized an inspiring conference with fruitful discussions and contributions about different aspects of microbial bioelectrochemical systems.

The city of Alcalá welcomed the scientists with a suffocating heat, making everyone dream of a *siesta* during the hottest part of the day. But there was no *siesta*: the meeting directly started with an insightful hands-on workshop about the basics of microbial electrochemistry. Luminaries like Lenny Tender, Bruce Logan, Korneel Rabaey, Abraham Esteve Núñez and Falk Harnisch elucidated the participants



with many aspects of electrochemical phenomena, techniques, reactor design and cultivation methods. In the evening a welcome reception was hosted and all conference attendees were guided through the venerable university buildings of Alcalá, which experienced many historical events and revealed interesting facts and stories to the visitors.

On the following day scientists presented and discussed their research in six different sessions including among others: fundamentals of microbial extracellular electron transfer, microbial electrochemical systems, environmental applications and microbial ecology. The invited speakers represented the *Who is who* of the (European) microbial electrochemistry community. Ricardo Louro talked about the different possibilities of interactions between outer membrane cytochromes and the subsequent implications. Uwe Schröder presented a new terminology for microbial electrochemical technologies that would facilitate the communication in our research field. César Torres demonstrated the potential role of microbial hydrolysis for the use of solid organic compounds in microbial electrolysis cells (MECs).

But also the other speakers gave interesting presentations: Christin Koch demonstrated the flow cytometry as an excellent tool for analyzing complex microbial communities. Extracellular electron transfer as a fundamental process is still poorly understood, according to Bernardino Viridis Raman microscopy is a promising method to study this controversially discussed topic. The scientific programme was complemented with an inspiring poster and discussion session in the sunny courtyard of the university, which liberally took place during the early evening.

During the conference there was always time in between to become acquainted with the city and its sights like

the birth house of Miguel de Cervantes, the cathedral and the Corral de Comedias. Despite the long and exhausting days most attendees and not only the PhD-students met afterwards for exchanging ideas and exploring the nightlife of Alcalá. Besides the never closing pubs an Asian inspired dance club was very popular among the participants. The 2<sup>nd</sup> EU-ISMET meeting was a great success and everybody is looking forward to the next conference and the nightlife 2016 in Rome.

*Carla Gimkiewicz & Benjamin Korth,  
PhD Students, UFZ*



*Abraham Esteve Núñez and Korneel Rabaey planted a tree stating that the conference was a CO<sub>2</sub> neutral event*



# Hands-on Workshop

Twenty-five delegates with academic and industrial background attended to explore different aspects of Microbial Electrochemical Technologies

In parallel with EU-ISMET meeting a hands-on workshop on microbial electrochemistry was organized at the Chemical Engineering teaching laboratories of University of Alcalá. Twenty-five delegates with academic and industrial background attended to explore different aspects of MET, from learning tricks for culturing electroactive microorganism to debating about reactor design and materials with Korneel Rabaey. Personal from Bio Group were pre-setting and conducting all the practical work so the students could smoothly work on couples and play with different models of EC equipments.



The long session was kindly interrupted with breaks for chatting and coffeeing, for lunching *Paella* and even for planting a maple tree to reduce the CO<sub>2</sub> fingerprint of the attendants. There was also time for hard electrochemistry with Lenny Tender and Antonio Berná before students start constructing their setups and performing different EC test with living cells. In that sense the workshop took advantage of the immediate vicinity of the Bioe group facilities for culturing and harvesting *plug&play Geobacter* cells that were the main actors of the show. This fact was indeed very much appreciated by the attendants, specially for those performing for first time cyclic voltammetry analysis of electroactive bugs by the expert guide of Falk Harnisch. Everything seems so easy when a fascinating bug and a charming teacher meet in the same bench!

We all recognized to be part of an enthusiastic communion that day, in part thanks to the invaluable role and effort of the lecturers specially to those who just landed from an overseas flight like Lenny Tender. At the end of the day, most of the students came back to the hotel of origin with the backpack full of ideas and plans for improving their own research. After all, that is what scientific meetings are for.

*Abraham Esteve-Núñez, Chair EU-ISMET 2014*

## Plant-MFC powers guardrail LEDs

Since the 5th of November 2014 the city Ede/Wageningen and HEMbrug in Zaandam (The Netherlands) are proud owners of 100m<sup>2</sup> Plant-Microbial Fuel Cells powering LEDs. Former-minister Jacqueline Cramers and the Mayors of Ede and Wageningen officially opened these first (public) sites of Plant-MFCs. This Plant-MFC product was developed and produced by a company called Plant-e ([www.plant-e.com](http://www.plant-e.com)) which is a spin-off of Wageningen University founded back in 2009. The 100m<sup>2</sup> Plant-MFC consists of 0.25m<sup>2</sup> modules which were consequently connected to harvesters that operate the Plant-MFC at the highest possible power output.

The electricity is used to power guardrail LEDs in Ede/Wageningen and a line of mini-LEDs which artistically lighting its surroundings in Zaandam. According to Marjolein Helder, director of Plant-e, realisation of this product is an important milestone. The proven technology shows that bioelectrochemical technology is really emerging from lab to application. Plant-e aims at further development of the technology for large-scale application within wetlands. More photos and a video of the opening can be found at <https://www.facebook.com/PlantMicrobialFuelCell>.



*David Strik*

# Meet the new board

Entering September 2014 for a period of 3 years, they were elected by a large number of ISMET members

## EU-ISMET

**Miriam Rosenbaum**



"Since June 2011, I am an Assistant Professor at the Institute of Applied Microbiology (iAMB) at RWTH Aachen University in Germany.

One research focus here is on tailoring microbial electrophysiology of anodic and cathodic reactions. The second research focus is on investigating and tailoring defined microbial co-cultures for diverse biotechnological applications.

Since early on, I am active in the BES community. Since mid-2013, I am chairing the ISMET webpage committee. Now as an ISMET board member, I will continue to develop the ISMET webpage into an active and highly used platform and further foster ISMET community exchange."

## PA-ISMET

**Enrico Marsili**

"I am a Lecturer at Dublin City University, Ireland, and Visiting Scientist at Singapore Centre on Environmental Life Sciences Engineering (SCELSE), Nanyang Technological University (NTU), Singapore. I am currently working on electroconductive biofilms for biocorrosion and bioelectricity application and have more than 10 years expertise in electrochemical characterization of biofilms and its metabolites. Although I have worked with single species biofilms in the past, my main research focus is on environmental mixed electroactive consortia.

As an ISMET board member, I will promote Microbial Electrotechnology in PA region and foster international collaboration among ISMET members."



## NA-ISMET

**Sarah Glaven**



"I have been a Research Biologist at the Naval Research Laboratory in Washington, DC, since 2011. My current research interests are in understanding extracellular electron transfer (EET) at biocathodes. We are taking two approaches: 1) fundamental electrochemical measurements to understand whether cathodes undergo long distance EET, and 2) an 'omics' approach using a combination of DNA, RNA, and protein sequencing to inform molecular genetics of cathode associated microbes. I have been a member of the BES community since 2006 and have been involved with ISMET since the first unofficial meeting in 2010 at the University of Massachusetts. I am honored to be elected to the ISMET board as the new Treasurer and will work to grow with the community of scientists interested in microbial electrochemistry."

# PhD Theses 2014

## North America

**Yates, Matt**



Title: Sustainable resource recovery and energy conversion processes using microbial electrochemical technologies

Supervisor: Bruce E. Logan

Affiliation: Pennsylvania State University, USA

Description: Sustainable processes for generating two products were assessed using METs. Sustainable formation of catalytically active palladium nanomaterials was studied using *Geobacter*. Hydrogen production from a biocathode using *Geobacter* or *Methanosarcina* as a catalyst was also studied.

**Ren, Lijiao**

Title: Examination of Bioelectrochemical Systems with Different Configurations for Wastewater Treatment

Supervisor: Bruce E. Logan

Affiliation: The Pennsylvania State University, USA

Description: This dissertation focuses on understanding of the operational factors affecting system performance, developing an energy-efficient high-quality wastewater treatment system, and evaluating of a high-throughput screening method, based on different bioelectrochemical systems.



## Asia-Pacific

**Kim, Kyoung-Yeol**



Title: Ultrafiltration Membrane-based Flow-through type

Microbial Fuel Cell for High-quality Water and Electricity Production

Supervisor: In S. Kim

Affiliation: Gwangju Institute of Science and Technology (GIST), China

Description: UF membrane integrated MFC was developed to produce both of the high-quality effluent and electricity simultaneously; and UF membrane modification methods were studied to enhance the power generation and reduce the membrane fouling.

**Commault, Audrey**

Title: Engineering Microbial Fuel Cell Biofilm Communities

Supervisors: Richard Weld and Gavin Lear

Affiliation: Lincoln Agritech Ltd, Lincoln University, Christchurch, New Zealand.

Description: This thesis focused on selecting and maintaining stable electrode biofilm communities that have efficient electron transfer properties and are suitable for specific functions such as biological oxygen demand (BOD) biosensing and electricity production.



**Sandipam, Srikanth**

Title: Strategies to enhance biohydrogenesis and bioelectrogenesis by regulating microbial fermentation and respiration processes

Supervisor: S. Venkata Mohan

Affiliation: Bioengineering and Environmental Sciences (BEES) Division, CSIR-Indian Institute of Chemical Technology (CSIR-IICT), Hyderabad, Andhra Pradesh, India

Description: Biochemical and electrochemical interface was used to understand the fermentative hydrogen production process and anodic microbial metabolism as well as biocathode operation (microbial fuel cells). Further, a few strategies were applied to enhance the hydrogen yields and power outputs.



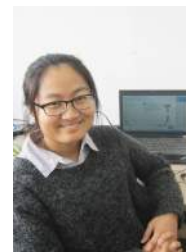
**Zhou, Mi**

Title: Converting glycerol to 1,3-propanediol using mixed-culture microbial electrochemical systems

Supervisors: Jurg Keller, Korneel Rabaey, Jingwen Chen

Affiliation: School of Environmental Science and Technology, Dalian University of Technology, China

Description: The yield of 1,3-propanediol from glycerol reduction by mixed bacterial populations was stimulated in a biocathode. The carbon and electron flows, electrochemical activity of biofilm, and long-term performance were investigated in the biocathode.



**Werner, Craig**



Title: Integrating microbial electrochemical technology with forward osmosis and membrane bioreactors: Low-energy wastewater treatment, energy recovery and water reuse

Supervisors: Gary Amy and Pascal Saikaly

Affiliation: Water Desalination and Reuse Center, King Abdullah University of Science and Technology (KAUST), Saudi Arabia

Description: Integrating forward osmosis and membrane bioreactors with microbial electrochemistry are two approaches to treat wastewater and recover energy and water. These technologies have low energy demands and approach energy neutrality.

**Sharma, Mohita**

Title: Sulphate reducing bacteria based biocathode for bioelectrochemical systems

Supervisors: Priyangshu M Sarma, Banwari Lal

Affiliations: The Energy and Resources Institute (TERI), New Delhi and TERI University, New Delhi, India

Description: The key hypothesis of the present study was to check if the metabolic flexibility of sulphate reducing bacteria (SRB) capable of reduction of sulphate to



sulphides can be replaced by reduction of organics to value added products using SRB based biocathode in BES.

## Europe

### De Vrieze, Jo

Title: *Methanosaeta* vs. *Methanosarcina* in anaerobic digestion: the quest for enhanced biogas production.

Supervisors: Nico Boon and Willy Verstraete

Affiliation: Laboratory of Microbial Ecology and Technology (LabMET), Ghent University, Belgium

Description: The contribution of *Methanosaeta* and *Methanosarcina* to methanogenesis in anaerobic digestion was investigated. Several strategies were applied to increase and/or stabilize methane production by (in)direct stimulation of the microbial community.

### Xafenias, Nikolaos

Title: Cr(VI) removal in bioelectrochemical systems with electrodes as electron donors

Supervisors: Charles Banks, Yue Zhang

Affiliation: University of Southampton, United Kingdom



Description: Xafenias investigated the potential and challenges associated with the remediation of toxic hexavalent chromium in bio-electrochemical cathodes.

Keywords: hexavalent chromium, lactate, biocathodes, microbial fuel cells, *Shewanella oneidensis* MR-1.

### Molognoni, Daniele

Title: Microbial Fuel Cells Application to Wastewater Treatment: laboratory experience and controlling strategies

Supervisor: Andrea Capodaglio

Affiliation: University of Pavia, Department of Civil Engineering and Architecture, Italy



Description: This thesis focuses on Microbial Fuel Cells technology application to wastewater treatment. Different prototypes were built, electrochemically characterized and long-term monitored, in order to determine and compare their performances once in steady-state operation.

### Van Eerten-Jansen, Mieke

Title: Bioelectrochemical methane production from CO<sub>2</sub>

Supervisors: Annemiek ter Heijne, Cees Buisman



Affiliation: Sub-department of Environmental Technology, Wageningen University, The Netherlands

Description: A methane-producing BES was studied in which microorganisms grow on an electrode and catalyse the conversion of CO<sub>2</sub> and electricity into methane. We show that BESs can also be used to produce medium chain fatty acids from acetate, using electricity as electron donor.

### Deeke, Alexandra

Title: Capacitive bioanodes for electricity storage in microbial fuel cells

Supervisors: Bert Hamelers, Annemiek ter Heijne, Tom Sleutels, Cees Buisman

Affiliations: Sub-department of Environmental Technology, Wageningen University, and Wetsus, Centre of Excellence for Sustainable Water Technology, The Netherlands

Description: Activated carbon granules form the core of a novel reactor design in which the granules are charged by electrochemically active microorganisms and electricity is harvested in an external discharge cell.



### Montpart Planell, Nuria

Title: Hydrogen Production from Wastewater in Single Chamber Microbial Electrolysis Cells: Studies towards its Scaling-up

Supervisors: Albert Guisasola Canudas and Juan Antonio Baeza Labat

Affiliation: Departament d'Enginyeria Química, Universitat Autònoma de Barcelona, Spain

Description: Studies on anode inoculation improvement (role external resistances and syntrophic consortia growth), methanogenic activity decrease (role of hydrogen retention time), hydrogen monitoring tools and use of complex wastewaters in single chamber MEC.



### Gil Carrera, Laura

Title: Municipal wastewater treatment in microbial electrolysis cells

Supervisors: Antonio Morán and Boris Tartakovsky

Affiliation: Chemical Environmental and Bioprocess Engineering Group, Natural Resources Institute, University of León, Spain, and Biotechnology Research Institute, National Research Council of Canada

Description: The feasibility of different MECs configurations for low strength domestic wastewater treatment and hydrogen production with low energy consumption was studied. The process scale-up from 50 mL to 10 L reactors and MECs in series demonstrated the viability of MECs to treat domestic wastewater.



### Pierra, Melanie

Title: Coupling dark fermentation and microbial electrolysis for hydrogen production: Formation and conservation of electroactive biofilm

Supervisors: Nicolas Bernet, Eric Trably

Affiliation: Laboratory of Environmental Biotechnology (LBE) and National Agronomy Research Institute (INRA), France

Description: The project was to associate dark fermentation and microbial electrolysis processes for enhanced hydrogen production. We focused on the relationship between microbial community structures and the associated macroscopic functions of the coupling.



## Best poster award of the German Chemical Society

At this year's *Electrochemistry 2014* conference (22-23 September, Mainz, Germany) of the German Chemical Society Sebastian Riedl and André Baudler – working group of Prof. Dr. Uwe Schröder (TU Braunschweig, Germany) - won the "Metrohm Autolab Best Poster Award". The posters title was *Long-term performance of primary and secondary electroactive biofilms using layered corrugated carbon electrodes*. The scientific committee chose three out of 180 posters of the conference.



For more information see:

<http://journal.frontiersin.org/Journal/10.3389/fenrg.2014.00030/abstract>



**Meeting dates:** October 1 – 4, 2015

**Abstract submission:** February 2 – April 30, 2015

**Registration:** March 2 onwards



**Meeting location:** Arizona State University campus, Tempe, Arizona, USA



We invite you to the 5th international meeting on microbial electrochemistry and technologies.

Topics to be covered in the meeting include:

*Fundamental research* – New pathways, extracellular electron transfer, synthetic biology, microbial ecology

*Applied research* – Wastewater treatment and other applications, materials and design, modeling and optimization



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