

Report on Division 3 Activities in 2016-2017

There are currently 1566 (down from 1620 in 2016) active members of Division 3 from Europe, Asia, North and South Americas, Africa and Oceania. Division 3 remains the second largest Division in the International Society of Electrochemistry (total 3774 members).

1) Division Officers for 2017/2018 term:

Chair: **Robert Kostecki** (USA)

Past Chair: **Stefano Passerini** (Germany)

Chair Elect: **Francesca Soavi** (Italy)

Vice- Chairs: **Kiyoshi Kanamura** (Japan), **Hiroyuki Uchida** (Japan)

2) Annual Meetings

67th ISE Annual Meeting, The Hague, Netherlands, 21-26 August, 2016.

Division 3 sponsored the following symposia:

Symposium 5: Current Progress in Microbial Electrochemical Technologies

Organizers:

Xochitl Dominguez-Benetton (Coordinator)

Flemish Inst Technological Research, Belgium

Bert Hamelers, Wetsus, the Netherlands

Korneel Rabaey, Universiteit Gent, Belgium

Uwe Schröder, TU Braunschweig, Germany

This vibrant symposium aims to gather current research in the field of microbial electrochemical technologies, including both electroseparations and electroconversions. The key advances towards in-depth electrochemical theory and engineering will be addressed, as well as new approaches on the application of transient electrochemical techniques and in situ electrochemical methods for a better understanding of microbial electrochemical systems. The symposium addressed a wide variety of applications ranging from power generation, co-generation of chemicals and electricity, resource recovery, desalination, electrosynthesis and intensification of coupled processes. Research presenting original and coherent modeling strategies to explain the electrochemical phenomena encountered in microbial electrochemical systems was encouraged. Electrochemical engineering can contribute to better reactor designs and process control, therefore these aspects applied to microbial electrochemical technology were also covered.

Symposium 6: Novel Materials and Devices for Energy Storage: Batteries for Tomorrow's World

Organizers:

Stefano Passerini (Coordinator), Helmholtz Institute Um/KIT, Germany

Erik Kelder, Delft University of Technology, the Netherlands

Robert Kostecki, Lawrence Berkeley National Lab, USA

Fokko Mulder, Delft University of Technology, the Netherlands

Peter Notten, Eindhoven University of Technology, the Netherlands

Marnix Wagemaker, Delft University of Technology, the Netherlands

The next generation of advanced rechargeable batteries will continue to rely on Li-ion chemistry, possibly with the integration of alloying, conversion and conversion-

alloying anode materials. Post Li-ion systems—such as Li-S, Li-air, Na-ion, etc.—are expected to enter the market, however, in the foreseeable future. Irrespective of the technology, the development of a detailed understanding of the fundamental properties of battery materials and the interactions of these materials with their environment is the key to further improvements in the energy density, safety, and lifetime of batteries. The electrolyte is also crucial for the improvements of these devices, especially with respect to safety. This symposium was therefore devoted to recent progress in the fundamental science related to batteries, especially for advanced battery systems. Studies related to all other (applied) aspects of batteries, including solid-state electrolytes, were also welcome.

Symposium 7: Novel Materials and Devices for Energy Conversion and Storage: Fuel Cells, Electrolysers, Regenerative Fuel Cells and Flow Batteries

Organizers:

Matthias Arenz (Coordinator), University of Copenhagen, Denmark
Andreas Friedrich, German Aerospace Center, Germany
Anne Hauch, Technical University of Denmark, Denmark
Robert Savinell, Case Western Reserve University, USA

The focus of this symposium was on cell, stack and functional materials for all types of low and high temperature fuel cells, regenerative fuel cells and flow batteries, as well as electrochemical generation of hydrogen by water electrolysis and synthetic fuels by electrolysis of CO₂ and steam.

Particular emphasis was given to in situ and operando characterisation and performance diagnostics, and to recent materials developments for durable cell components, as well as modelling studies to improve understanding of electrochemical reaction processes, transport and degradation phenomena. Novel chemistries and cell designs were also included.

Symposium 8: Novel Materials and Devices for Energy Storage: Capacitors

Organizers:

Elzbieta Frackowiak (Coordinator), Poznan University of Technology, Poland
Peter Coenen, VITO, Belgium
Wataru Sugimoto, Shinshu University, Japan

This symposium addressed all fundamental and practical aspects on electrochemical capacitor research, development and applications. Topics include capacitor performance for power uses such as electric vehicles and energy storage application as well as advanced materials for capacitors (e.g., carbonaceous materials and their composites, polymers, inorganic materials). Novel insights into capacitors, such as computer simulations and in situ study of electrode/electrolyte interfaces, new designs/concepts for fabricating high performance devices, and synthesis of advanced electrolytes were invited.

Topics included:

- Double-layer capacitance and pseudocapacitance of porous materials
- Materials with primarily faradaic pseudocapacitance: metal oxides, nitrides, sulfides, and other advanced inorganic materials, and conducting polymers
- Pseudocapacitance related to redox reactions at the carbon/electrolyte interface: iodides, quinones
- Characterization methods for physical structures and fundamental electrochemical processes of new electrode materials and architectures
- Optimization of components: current collectors, electrodes, electrolytes, separators, and packaging
- Hybrid capacitors: lithium ion capacitor and other related systems

- Design of new devices and hybrid systems combining capacitors and other power sources (e.g., batteries, fuel cells)
- Capacitor modeling for predicting performances of materials and devices
- New electrolytes for capacitors (redox active electrolytes and ionic liquids)
- Aging and corrosion phenomena in capacitors

Symposium 12: EC Power Sources: Principles of Materials, Design and Operation

Organizers:

Deborah Jones (Coordinator), Université de Montpellier

France Peter Bouwman, HyET, the Netherlands

Eril Kjeang, Simon Fraser University, Canada

François Lapicque, Université de Lorraine, France

This symposium addressed critical engineering challenges and opportunities associated with electrochemical energy conversion and storage technologies, including batteries, fuel cells, electrolyzers, capacitors, and solar cells. Particular emphasis was on multi-/interdisciplinary approaches and solutions that contribute to bridging the gap between scientific advances and device functionality.

Topics included:

- Design of novel component and cell architectures
- Membrane electrode assembly integration
- Transport phenomena, including thermal and water management
- Computational modeling and simulation of performance and durability
- Interactions between electrochemistry and mechanics
- System integration and hybridization
- In situ diagnostics and health monitoring
- System design and operation under extreme conditions
- Integration of new materials and cell components to large FC stacks
- Heat integration in combined heat and power units with innovative FC components
- Advances in hybridization of energy converters for optimal heat or power delivery
- Ageing issues induced by particular operation, in particular by hybridization
- Strategy for energy delivery for higher durability of FC systems

Symposium 18: Electrochemistry, Photoelectrochemistry and Bioelectrochemistry of Artificial Photosynthesis: Recent Advances in CO₂ Conversion to Products

Organizers:

Deepak Pant (Coordinator), VITO, Belgium

Monica Baroso, Utrecht University, the Netherlands

Gabriele Centi, University of Messina, Italy

Brian Seger, DTU Lyngby, Denmark

Wilson Smith, Delft University, the Netherlands

The interest to use carbon dioxide in a circular economy as a raw material and as an energy carrier is coming closer to reality. Worldwide research projects and industries are working on this topic with high priority and there are several concepts to convert CO₂ to a valuable fuel for the future. One of the main reasons for this is the availability of CO₂ - it is available everywhere and to reduce greenhouse gas emissions it should be a good way to bring these back to the utilization. The CO₂ originating from the use of fossil resources continues to accumulate in the atmosphere, accelerating climate change with disrupting impacts on the biosphere. On the other hand one of the main hurdles is the need of energy to utilize the CO₂ as a stable molecule and there are several approaches needed to overcome this. The chemical industry which heavily

relies on these non-renewable and scarce fossil resources is looking for sustainable alternative resources to deliver the chemicals our society needs without the related environmental burden. While there are important scientific and technological challenges hindering the exploitation of CO₂ as a chemical feedstock, it offers great potential to couple environmental protection and economic growth. Today also a rising amount of sustainable energy is produced by using solar and wind and the carbon capture and utilization technologies are an opportunity to store peak energy in an efficient way. One of the major set of technologies being applied towards this end include electron mediated processes such as electrochemistry, bioelectrochemistry, plasmachemistry and photochemistry which are emerging technologies with the possibility to comply with varying energy supply (fast switch on and off) such as renewable energy. The symposium focused on these specific technologies.

3) Topical Meetings

Division 3 co-organized the 20th Topical Meeting of the International Society of Electrochemistry: “Advances in Lithium and Hydrogen Electrochemical Systems for Energy Conversion and Storage” on March 9-12, 2017 in Buenos Aires, Argentina

Organizing Committee:

Agustin E. Bolzan, La Plata, Argentina (co-chair)
Candace Chan, Tempe, USA
Deborah Jones, Montpellier, France
Robert Kostecki, Berkeley, USA
Ezequiel P.M. Leiva, Cordoba, Argentina (co-chair)
Yan Yao, Houston, USA

Local Organizing Committee:

Ernesto J. Calvo, Universidad de Buenos Aires, Argentina
Jose L. Fernandez, Universidad Nacional del Litoral, Argentina
Guillermina Leticia Luque, Universidad Nacional de Cordoba, Argentina
Arnaldo Visintin, Universidad Nacional de La Plata, Argentina

This ISE topical meeting was attended by 203 participants from 30 countries, mainly from the S&N Americas and Europe. The success of the meeting was demonstrated not only by the number of attendees but also by the presence of the National Research Council (CONICET), the Ministry of Science Technology and Productive Innovation (MINCYT) and YTEC Tecnología, numerous sponsors and 9 exhibitors. The meeting provided excellent and ample opportunities for participants to share and discuss recent advances in lithium-ion batteries and hydrogen fuel cells, and to establish new collaborations between attendees from different research institutions.

4) Sponsored Meetings:

ISE Division 3 supports academic events, which are aligned with ISE mission and relevant to Division 3 science and technology areas of interest in electrochemical energy conversion and storage. Financial support is primarily dedicated to the sponsorship of Student Poster Awards.

Division 3 has sponsored the following meetings in 2016 and 2017:

- **International Symposium on Polymer Electrolytes 15** 15-19 August 2016, Uppsala, Sweden

- **Gordon Research Conference: Fuel Cells** 7-12 August 2016, Eaton, MA, USA
- **Reactivity of nanoparticles for efficient and sustainable energy production –IV** 7-12 August 2016, Gilleleje, Denmark
- **International Meeting on Ionic Liquids for Electrochemical Devices** 11-13 July 2016, Rome, Italy
- **14th International Conference on Electrified Interfaces** 3-8 July 2016, Singapore, Singapore
- **ELectrospinning for Energy 2016** 22-24 June 2016, Montpellier, France
- **Controlling Lithium Battery Interfaces** 27 May 2016, Orlando, Florida, USA
- **5th International Conference on Advanced Capacitors** 23-27 May 2016, Otsu, Japan
- **32nd PSI Electrochemistry Symposium: Electrolytes - the Underestimated Player in Electrochemical Processes** 27 April 2016, Villigen PSI, Switzerland
- **Hydrogen Days 2016** - 8 April 2016, Prague, Czech Republic
- **International Meeting on Electrochromics** 28 August -1 September 2016, Delft, Netherlands
- **Advanced Batteries, Accumulators and Fuel Cells** 28 August 2016, Brno, Czech Republic
- **International Conference on Advances in Semiconductors and Catalysts for Photoelectrochemical Fuel Production** 5-6 September 2016, Berlin, Germany
- **European Materials Research Society Fall Meeting 2016** 19-22 September 2016, Warsaw, Poland
- **3rd International Conference on Sodium Batteries** 7-9 December 2016, Geelong, Australia
- **3rd International Workshop on Nano Materials for Energy Conversion**, May 3-6, 2017, Ho Chi Minh City, Vietnam
- **CARISMA 2017**, April 9-12-2017 Newcastle upon Tyne, UK
- **European Materials Research Society Spring Meeting 2017** 22-26 May 2017, Strasbourg, France
- **VI Symposium on Hydrogen, Fuel Cells and Advanced Batteries**, June 9-23, 2017, Porto, Portugal.
- **21st International Conference on Solid State Ionics** 18-23 June 2017, Padova, Italy.
- **Metal-air Batteries International Congress**, June 4-8, 2017, WALQA Technology Park, Huesca, Spain
- **5th International Symposium on Enhanced Electrochemical Capacitors**, 10–14 July 2017 • Jena, Germany.

Division 3 will sponsor the upcoming meetings:

- **Alkaline Fuel Cells, and Water and Alcohol Electrolysers**, Canada: Kingston, Ontario, 2017
- **Advanced Batteries, Accumulators and Fuel Cells**, September 10-13-2017, Brno, Czechia
- **Italian Crystal Growth 2017**, November 20-21, 2017, Milano, Italy

5) Get-together/Networking:

Division 3 held a luncheon meeting during 67th ISE Annual Meeting in The Hague, Netherlands in 2016 and will hold a similar meeting during 68th ISE Annual Meeting in Providence, USA in 2017. The primary purpose of these informal gatherings is to inform Division 3 members on the Division business activities. It is always an open forum for Division 3 members to discuss various issues and inquiries.

6) Division Poster Awards

The Division sponsored Student Poster Awards at:

- **20th Topical Meeting** of the International Society of Electrochemistry: “Advances in Lithium and Hydrogen Electrochemical Systems for Energy Conversion and Storage”, 9-22 March 2017, Buenos Aires, Argentina
- **67th ISE Annual Meeting** (21 – 26 August 2016, The Hague, Netherlands)
- ...and several ISE-sponsored conferences listed above.

7) **Scientific Meetings Committee**

Francesca Soavi attended the SMC meeting on March 31, 2017 in Lausanne. The information received at the meeting was distributed promptly to Division 3 Officers. This annual meeting of Division Officers and other ISE Staff is dedicated to discussions of ISE business matters, including elections of ISE officers, divisional budget and fund raising efforts, ISE awards, organization of future ISE annual, topical and sponsored meetings, selection of prospective symposia topics.

8) **Contribution to *Electrochimica Acta* Special Issues**

Electrochemical Acta Special Issue containing selected papers presented at the 67th ISE Annual Meeting in The Hague, Netherlands. Guest Editors for Division 3 sponsored symposia (5 through 8, 12 and 18) are:

Symposium 5: Uwe Schroeder
 Symposium 6: Stefano Passerini
 Symposium 7: Matthias Arenz
 Symposium 8: Wataru Sugimoto
 Symposium 12: Deborah Jones
 Symposium 18: Deepak Pant

Electrochemical Acta Special Issue of selected papers presented at the 68th ISE Annual Meeting in Providence, USA is also planned. Division 3 sponsored symposia will contribute to this Journal issue.

Robert Kostecki
 (on behalf of ISE Division 3)
 21/08/2017