

# Division 7 Physical Electrochemistry 2024 Report

## Division 7 officers:

Katrin F. Domke, University of Duisburg-Essen (Chair)

Shen Ye, Tohoku University (Past Chair)

Mark Symes, University of Glasgow (Chair Elect)

Katarzyna Hnida-Gut, Leibniz Institute for Innovative Microelectronics and Bin Ren, Xiamen University (Vice-Chairs, 2023-2024)

The activities of Division 7 in 2024 are summarised below:

## Organization and co-organization of symposia at annual ISE meetings

### 1) 75<sup>th</sup> Annual Meeting of the ISE, 18-23 August 2024, Montreal, Canada

Division 7 is involved in organizing the following symposia:

#### Symposium 2

#### Scanning Probe Microscopies: Towards quantitative electrochemistry

Sponsored by:

Division 1, Analytical Electrochemistry

Division 7, Physical Electrochemistry

Description:

This symposium will be dedicated to presentations illustrating the breadth of electrochemical scanning probe microscopies. Contributions covering the fundamentals, applications, method development, instrument design or quantitative aspects (stability, reproducibility, sensitivity) or numerical simulations are welcome. This symposium will include recent advances in electrochemical imaging for quantitative analysis using:

- Atomic force microscopy
- Scanning tunneling microscopy
- Kelvin probe force microscopy
- Scanning electrochemical cell microscopy
- Scanning ion microscopy

Symposium Organizers:

Wojciech Nogala (Coordinator) Institute of Physical Chemistry Polish Academy of Sciences, (wnogala@ichf.edu.pl)

Rasa Pauliukaite, Center for Physical Sciences and Technology, Vilnius

Joshua Byers, Université du Québec à Montréal

Zhifeng Ding, Western University

#### Symposium 7

## **Electrocatalysis: From Understanding Electrochemical Processes at the Atomic Level to Industrial-Scale Systems**

Sponsored by:

Division 3, Electrochemical Energy Conversion and Storage

Division 5, Electrochemical Process Engineering and Technology

Division 7, Physical Electrochemistry

Description:

The need for clean and renewable energy sources and carriers drives an ever-increasing interest in electrochemical technologies and devices, such as water electrolyzers, fuel cells, and rechargeable batteries, to mention a few. Electrochemical technologies also attract considerable attention in the conversion or production of simple chemical compounds, such as H<sub>2</sub>O, H<sub>2</sub>, CO<sub>2</sub>, CH<sub>3</sub>OH, C<sub>2</sub>H<sub>5</sub>OH, NH<sub>3</sub> etc. Once an electrocatalyst for a given reaction has been found, it will perform the same sequence of atomic-level events regardless of whether the reaction takes place in an experimental cell of a university-based electrochemistry laboratory or in an industrial scale device (electrolyser, fuel cell, reactor). However, industrial-scale electrochemical devices must be optimized to minimize their capital cost and operational expenses and to maximize their long-term performance and profitability, imposing further demands on electrocatalytic materials. The development of the most suitable electrocatalysts for electrochemical reactions is a complex process involving several stages of design, synthesis, characterization, testing, and optimization. While until recently, new electrocatalysts were found by trial-and-error, utilizing accumulated expert knowledge, and quite often benefitting from serendipity, modern approaches increasingly utilize theoretical and computational methods to orchestrate and accelerate the process of electrocatalyst discovery and development. Computational approaches provide tools to rapidly identify candidate electrocatalytic materials with a set of properties that promise to meet the requirements of a specific electrochemical process or device. In this new leading paradigm of electrocatalyst research and development, close collaboration between theoreticians and experimentalists is becoming ever more important as to systematically explore materials modification strategies and assess the suitability of newly proposed electrocatalytic materials. The symposium will provide a forum for academic and industrial researchers with diverse backgrounds and research interests in the fundamentals of modern electrocatalysis. It welcomes both computational and experimental research findings. Its objective is to present the most recent developments in electrocatalytic materials for the:

- Hydrogen and oxygen evolution reactions (HER, OER)
- Hydrogen oxidation and oxygen reduction reactions (HOR, ORR)
- CO<sub>2</sub> reduction reaction (CO<sub>2</sub>RR)
- Electrocatalytic hydrogenation (ECH)
- Nitrogen and nitrate reduction reaction (NRR)
- Other reactions

Symposium Organizers:

Gregory Jerkiewicz (Coordinator) Queen's University, ([gregory.jerkiewicz@queensu.ca](mailto:gregory.jerkiewicz@queensu.ca))

Michael Eikerling, Forschungszentrum Jülich

Samira Siahrostami, Simon Fraser University

Shigenori Mitsushima, Yokohama National University

### **Symposium 13**

#### **Double layer reloaded: theory meets experiments**

Sponsored by:

## Division 7, Physical Electrochemistry

### Description:

An in-depth understanding of electrochemical reactions is intimately connected with understanding the structure, dynamics, and properties of the electrode-electrolyte interface on the molecular scale. Recent experimental and theoretical studies provide evidence that this interface is considerably more complex than described by traditional double-layer theories. The symposium aims to foster the development of a unified microscopic picture of the electrochemical interface by collecting contributions on:

- structure and dynamics of the electrolyte solution near the electrode surface, specifically of interfacial water and ions
- electronic structure and potential distribution at the interface
- ab initio calculations and simulations of electrochemical interfaces
- studies of the interface structure and dynamics by in situ structure-sensitive methods and spectroscopy
- electrochemical studies of interface structure and its effect on electrochemical reactivity
- electrochemical interfaces beyond the metal / aqueous electrolyte interface, e.g. interfaces involving ionic liquids, oxides, or liquid-liquid interfaces

### Symposium Organizers:

Olaf Magnussen, (Coordinator) Kiel University, (magnussen@email.uni-kiel.de)

Jun Cheng, Xiamen University

Daniel Guay, INRS

Leanne Chen, Guelph University

## **Symposium 14**

### **Recent Advances in Photoelectrochemistry and Plasmonics: Fundamentals and Applications**

#### Sponsored by:

Division 7, Physical Electrochemistry

Division 3, Electrochemical Energy Conversion and Storage

#### Description:

Photoelectrochemistry and plasmonics have been attracting significant interest in the scientific community toward addressing the pressing environmental, energy and medical issues. This symposium provides an international and interdisciplinary forum for the presentation and discussion of the latest advances in photoelectrochemistry and plasmonics.

Topics of interest include but are not limited to:

- Concept and design of photoelectrochemical cell system
- Synthesis and characterization of photocatalysts and quantum dots
- Exploration of new materials for solar energy conversion
- Generation of fuels and chemicals with photoelectrochemical processes (e.g., water splitting, CO<sub>2</sub> reduction, N<sub>2</sub> reduction, and methane oxidation)
- Light-driven environmental remediation and disinfection
- Sunlight-driven energy conversion;
- Simulation and modeling of photoelectrochemical systems.

#### Symposium Organizers:

Aicheng Chen (Coordinator) University of Guelph, (aicheng@uoguelph.ca)  
Minghua Zhou, Nankai University  
Fatwa F. Abdi, Helmholtz-Zentrum Berlin  
Leyla Soleymani, McMaster University

### **Symposium 15**

#### **Advances in methods for in-situ and operando study of electrochemical interfaces and systems**

Sponsored by:  
Division 7, Physical Electrochemistry

#### **Description:**

The atomic scale and molecular level understanding of phenomena taking place at electrified interfaces under realistic working conditions remains one of the most challenging issues in electrochemistry. Electrochemical measurements alone are not enough to accurately describe the complex interplay between charge and mass transfer, electric double-layer structure, redox dynamics, and chemical conversion and changes at the electrode-electrolyte interface during the application of a potential.

In this context, spectroscopy methods using light as the excitation source and/or signal, including surface-sensitive diffraction, and electronic/vibrational spectroscopies, have allowed obtaining chemical and structural information on surfaces in real-time and non-destructive way. When coupled with electrochemical control of the interface, these methods can characterize a wide range of complex electrochemical interfaces. This symposium will focus on:

- new or improved method developments,
- imaging the interface to reveal structure-performance relationship,
- probing interfaces in electrochemical devices,
- new insights into electrochemical interfaces in battery, electrocatalysis, and electroanalysis, etc. using established methodologies,
- challenges/solutions for the in-situ and operando use of spectroelectrochemical methods, single molecule studies at electrochemical interfaces.

#### **Symposium Organizers:**

Ian Burgess (Coordinator) University of Saskatchewan, (ian.burgess@usask.ca)  
Jakub Drnec, European Synchrotron Radiation Facility (ESRF)  
Ana M. Gómez-Marín, Instituto de Química de São Carlos  
Bin Ren, Xiamen University

### **Symposium 16**

#### **General Session**

Sponsored by: All Divisions

#### **Description:**

This symposium will cover conceptual aspects, fundamentals, and applications of all ISE areas which are not compatible with the topical symposia. This symposium will provide a forum for researchers and graduate students to present their recent advanced research results of general interest to the ISE meeting attendees. The purpose of this symposium is to foster and promote work in both electrochemical sciences and technologies, and to stimulate researcher and student interests and participation in ISE. A competition for the best poster in electrochemical sciences and technologies will be part of the symposium. Best student prize will be given to the presenting student author on the winning paper.

This symposium will cover all ISE areas not compatible with topical symposia. Oral contributed papers will be programmed in some related order, depending on the titles and contents of the submitted abstracts.

Symposium Organizers:

Jean Lessard (Coordinator) Université de Sherbrooke, (Jean.Lessard@USherbrooke.ca)

Wataru Sugimoto, Shinshu University

Clara Santato, Polytechnique Montreal

Donal Leech, University of Galway

## **2) 76<sup>th</sup> Annual Meeting of the ISE, 2025, Mainz, Germany**

Division 7 is planning to be involved in organizing the following symposia:

### **i) AI for Electrochemistry, Symposium 15**

Sponsored by Division 7

Description:

The fast development of artificial intelligence (AI) is transforming the world in many ways, and is also changing how scientists do research. Many long-standing problems in electrochemistry that electrochemists dream of solving, all of sudden, seem within reach with the help of AI. In this symposium, we wish to bring together researchers from different backgrounds to discuss in what ways AI can reshape electrochemistry, with particular emphasis on the following questions.

- To what extent can AI acceleration on ab initio modeling of electrochemical systems bridge the gap between simulation models and experiment?
- How far can AI push the spatial and temporal limits of state-of-the-art in situ/operando characterization techniques in probing electrochemical systems?
- How can AI/robotics help close the loop of multi-level optimization of electrochemical systems ranging from materials design, hierarchical structure engineering to device optimization?

Symposium Organizers:

Jun Cheng (Coordinator), U Xiamen, China

Marialore Sulpizi, RU Bochum, Germany

Katrin F. Domke, U Duisburg-Essen, Germany

De-en Jiang, Vanderbilt U, USA

### **ii) Experimental and theoretical methods for atomistic understanding of electrochemical interfaces, Symposium 14**

Sponsored by Division 7

Description:

The chemistry of the electrode-electrolyte interface is a key factor for the performance of electrochemical devices such as fuel cells, batteries, electrolyzers, and capacitors. Capturing this interfacial chemistry requires powerful experimental methods and simulations. From the experimental side, methods such as (operando) X-ray spectroscopy, vibrational spectroscopy, X-ray scattering, and scanning tunneling microscopy provide key insight into the morphology, composition and (electronic) structure of the interface. Meanwhile, theoretical methods provide insight into reaction paths, molecular arrangements, electronic structure properties, and atomic-scale dynamics. To disentangle the full complexity of interfacial chemistry, a combination of theoretical and experimental methods is often necessary. Therefore, this symposium not only provides a platform to discuss recent developments and results of advanced experimental and theoretical methods, but also fosters experiment-theory collaboration.

Organizers:

Katharina Doblhoff-Dier, U Leiden, NL (coordinator)

Rik Mom, U Leiden, NL

Helmut Baltruschat, U Bonn, D

### iii) Mechanisms of molecular electrochemistry for (bio)catalysis, (bio)sensing, and electronics

Sponsored by Division 6, co-sponsored by Divisions 1, 7

#### Description:

A simple electron (/charge, in general) transfer taking place at molecular level can be at the origin of many contemporary applications in very diverse fields of our daily life. This symposium is focused on recent advances in the charge and mass transfer/transport processes occurring at electrode surfaces, suitably functionalized with new electroactive, bio-inspired and biomimetic molecules (including polymers). The novel materials and architectures, designed and crafted at molecular level, can enable unprecedented functionality from the physical electrochemistry point of view concerning charge transfer/transport properties. Furthermore, they can serve as novel molecular components to devise low-cost, low-power (bio-inspired) electronics, optoelectronics, (bio-) chemical sensing platforms, highly efficient catalysts. The aim is to (i) highlight fundamental approaches to devise novel functionalized molecular systems, 2D and 3D material architectures, with particular attention to synthetic receptors and biomimetic interfaces, and (ii) investigate how the structure of molecules affects the molecular interactions, the charge transfer/transport phenomena in molecular systems, molecular junctions and (biomimetic) interfaces to develop reliable and robust molecular or nanoscale bio-inspired devices for next-generation (opto-)electronics, sensing and catalysis.

Organizers: Federico Polo (lead organizer), Ca' Foscari University of Venice, Italy  
Magdaléna Hromádová, J. Heyrovský Institute of Physical Chemistry, Czech Republic  
Hye Jin Lee, Kyungpook National University, South Korea  
Valentina Pifferi, University of Milan, Italy  
Kristina Tschulik, Ruhr-University Bochum, Germany

### Organization and co-organization of ISE Topical Meetings

- Past Meetings:

- Future Meetings:

**38<sup>th</sup> ISE Topical Meeting**, Nanomaterials in Electrochemistry (Manchester, UK), 8 - 11 September 2024.

**xx<sup>th</sup> ISE Topical Meeting**, Sustainable Electrochemical Energy Materials: Theory and Practice (Aalto University, Finland), 2026/27.

### Sponsoring of International Conferences

X-rays and electronic operando techniques for electrocatalysis (Ecatalytix), 3-5 Apr 2024, Strasbourg

55th Heyrovský Discussions (55 HD), 13th International Zdravko Stoyanov Symposium on Electrochemical Impedance Analysis (13 EIA), 9-13 Jun 2024, Třešť, the Czech Republic

8th Ertl Symposium on FUNDamental to Scale-up science in Electrochemistry (FUSE), 26-29 Jun 2024, Esslingen, Germany

International Symposium on Electrochemistry and Surface Science in Honour of Professor Jacek Lipkowski's 80<sup>th</sup> Birthday, University of Guelph, 14-17 Aug 2024 (satellite meeting of the 75<sup>th</sup> ISE Annual Meeting)

3rd Gerischer-Kolb Symposium (GKS), 16-19 Oct 2024, Günzburg, Germany

Anion Exchange Membrane Fuel Cells - A new source of innovative green energy generation, 30-27 Oct 2024, Haifa, Israel

## Awards

The **Brian Conway Prize in Physical Electrochemistry 2024** was awarded to Professor Di Wei in recognition of his outstanding contributions to the field of electrical double layer regulation for controlled charge transport based on iontronics. Controlled charge transport is a crucial aspect of diverse scientific and technological processes, for example, as energy and information carrier as well as a probe for material properties and kinetics. Prof. Wei has in this way greatly expanded our knowledge of traditional electrochemical interfaces.

Award Committee

Katrin F. Domke, U Duisburg-Essen, Germany (chair)  
Clara Santato, Polytechnique Montréal, Canada  
Scott Donne, U Newcastle, Australia

In **2025** the Division will be associated with the Alexander Kuznetsov Prize for Theoretical Electrochemistry.

Award Committee

Mark Symes (Division Chair)  
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## Election for Chair and Vice-chairs of Division 7

During the Division Lunch at the ISE AM in Montreal, Division 7 officers will announce the search for candidates for the election of the chair and vice-chair in October 2024.

## Miscellaneous

- ask for suggestions for TM
- Symposia suggestions wanted for AM 2026 in Sydney