Electrochem 2019 Glasgow

Conference Report for the International Society of Electrochemistry

Mark D. Symes (University of Glasgow) and
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Introduction to Electrochem2019

Electrochem is an annual meeting of electrochemists that takes place at a different location within the UK or Ireland in August/September every year.

The conference is organised jointly by the RSC Electrochemistry Group and the SCI Electrochemical Technology Group, with the Institute of Corrosion joining the conference in odd-numbered years (and so Electrochem2019 also included the 60th Corrosion Science Symposium).

The conference includes a number of high-profile plenary lectures and award ceremonies (see below), but also makes a deliberate effort to encourage student participation, through talks, poster sessions and the opportunity to rub shoulders with some of the luminaries in the field. Student rates are heavily subsidized and both RSC and SCI provide generous bursaries and presentation awards to maximize student participation.

Electrochem2019 was the 26th such Electrochem conference, a joint venture between the University of Strathclyde and the University of Glasgow, held in the University of Strathclyde's fantastic Technology and Innovation Centre right in the heart of Glasgow, 26th-28th August 2019.

According to the readers of *Rough Guides* travel books, Glasgow is the world's friendliest city, and the delegates at Electrochem2019 were exposed to the full range of Glasgow's active social life, including a civic reception in the spectacular Glasgow City Chambers and a traditional Scottish ceilidh on the first evening, and the sumptuous conference banquet on the second night (see picture).

Electrochem 2019 saw the participation of 195 registrants from more than 30 countries worldwide, which showed the influence of the subject in our everyday lives across chemistry, materials, medicine, environment and infrastructure.

Scientific Programme

Electrochem2019 saw the inaugural presentation of the RSC Roger Parsons medal for early career researchers, alongside the more established awards such as the RSC

Faraday medal, the SCI Castner medal and the Institute of Corrosion's Evans award. Meanwhile, this year the organizers invited the European Academy of Surface Technology (EAST) to attend the conference and to present their Schwäbisch-Gmünd Early Career Researcher Prize at Electrochem2019. There were also over 60 other talks and another 60+ posters presented at the conference. Abstracts from these award lectures are given below, along with a complete list of oral contributions.

Obviously none of this would have been possible without the help and support of a great many support staff from the universities and City Chambers. Special mention must go to Joy Leckie, Nic Toshner, Ewa Kosciuk and Karla Cunningham for their efforts. We are also greatly indebted to the ISE for their generous support of this conference and in particular to the ISE UK rep (Guy Denuault) who gave a short presentation before the Faraday Plenary medal talk to raise awareness of the ISE and its activities.

Faraday Medal: Martin Winter

Electrolyte –The Unrecognized Hero of the Battery World

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Abstract:

Among the four vital parts of each battery, namely anode, cathode, separator and electrolyte, the first two have been recognized for gathering all the headlines and glamour so far. However, it is the electrolyte as an unhonoured hero of the battery world, that plays a central key role in terms of design and control of battery cell processes as well as influencing material interactions, performance, long-term stability, cost and last but not least the safety of all types of current and future batteries. The right choice of electrolyte and its components hand in hand with *ad hoc* interfacial/interphasial chemistries determine the relevant properties that dictate the overall performance of rechargeable batteries.[1]
Still, the overall performance of batteries is limited by the fundamental behavior of the materials used, even for the present and potential future high-performers, the lithium ion and lithium metal batteries. Market demands for higher-energy and higher-power lithium-based batteries force researchers towards identifying new liquid electrolyte formulations, polymer and ceramic solid as well as hybrid electrolytes of them.[2-4] By combining different electrolyte constituents, electrolyte and battery cell chemistry can be optimized and tailored for a specific application. Profound study by means of selected electrochemical, analytical and spectral techniques supported by theoretical calculations and simulations as well as integration of gained knowledge comprising vital parameters and processes is the key towards desired advancements of lithium-based cell chemistries and their effective performance. In this presentation, emphasis is set on the physicochemical, electrochemical and safety aspects relevant for cell operation. With this in line, performance characteristics, current limitations and recent breakthroughs will be critically reviewed and discussed.

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Castner Medal: Keith Scott

Electrochemical Engineering Science. 40+ years of process and materials developments

Keith Scott

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Abstract:

Electrochemical Engineering Science (EES) is a multidisciplinary research activity exploring applications of electrochemistry in many areas such as; energy storage, power generation, electrolysis, green energy, sensors and environmental protection and treatment. The EES field includes novel research for fuel cells, batteries, hydrogen generation, bioelectronics, cellular and microbial catalysis, etc and explores new techniques to synthesise electro-catalyst, nanomaterials and membrane materials and optimise electrode structures. EES has at its core electrochemical and spectro-chemical analysis to understand fundamental mechanisms and the exploration of electrochemical technologies at the pilot scale for electrolysis, power generations and more [1].

Over the last 5 decades major developments have occurred in the electrochemical based industries in areas such as electrosynthesis, batteries, fuel cells, hydrogen technologies, enzyme and microbial fuel cells, effluent treatment and recycling [2]. These have been partly driven by advances in better performing materials and in cell design and operation. This lecture will take a personal, historical perspective of several of the aforementioned applications including electro-organic synthesis, power sources and metal recovery and recycling. Many of these have been commercialised or developed to high TRLs, only to be shelved due to poor long term materials performance, more economic competition, or loss of market potential.

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Parsons Medal: Alison Parkin

Fourier transforming protein film electrochemistry

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Abstract:

Redox reactions underpin the mechanisms of life and understanding how bacteria use non-precious transition metal elements to activate H_2-production, CO_2-reduction and N_2-fixation is important for learning how to design sustainable energy catalysts. Notably, such multi-electron redox reactions always occur within enzymes that contain electron-transfer centres that act as a “wire”, transferring electrons between the protein surface and the catalytic centre buried in the middle of the protein. While film-electrochemistry has proven to be a powerful technique for probing the catalytic reaction mechanisms of such enzymes, it has been challenging to unpick the mechanisms of reversible electron-transfer along the protein “wire” using traditional voltammetric methods. In collaboration with Prof Alan Bond (Monash) and Prof David Gavaghan (Oxford), the Parkin group is developing protein film alternating current voltammetry as a method which can simultaneously measure the catalytic redox activity and reversible electron transfer processes of metalloenzymes. This insight has been used to guide the design of protein mutations that produce re-wired H_2-enzymes which are more active and efficient H_2-production bio-catalysts.

Evans Award: Tetsuo Shoji

Mechanics and Mechanisms of Stress Corrosion Cracking

– Role of hydrogen as all-round player –

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Abstract: Stress corrosion cracking is a well-known degradation mode in various industries such as oil refinery plants, chemical process plants and various energy conversion plants. Stress carrion cracking is one of the typical degradation modes cause by synergy of multiple critical factors such as mechanics, materials and environments. There have been numerous research publications on phenomenological understanding of cracking mechanisms but still fundamental mechanistic understanding need more work to find a solution for industries. Recent atomistic modelling studies of metallic oxidation by water suggest a significance of the role of hydrogen in oxidation[1] and some experimental observation had been reported in hydrogen-vacancy cluster and promotion of diffusiviity[2,3]. Hydrogen plays role in various aspects such as an interaction with surrounding atoms through electron transfer from metal to hydrogen to form negatively charged/positively charged hydrogen in transition metals and their alloys, with atomic defects to form hydrogen-vacancies cluster, with existing surface oxides to form degraded(non-protective) oxides, with grain boundary or interface to promote diffusivity. Fig. 1 shows the interaction of various mechanics, materials and environmental factors in a process of SCC crack initiation and propagation including macroscopic stress field. A cooperative research work is going on to verify this scenario of critical role of hydrogen in SCC with electric power generation industry. Also, new alloys were designed and fabricated based upon this possible role of hydrogen on oxidation and SCC as well as oxygen and verification work is also going on to show an excellent SCC resistance under the environment where hydrogen is phenomenologically known to play a critical role in the system. There need much more works for better mechanistic understanding of SCC initiation and propagation with special emphasis on all-round atom, hydrogen. Some of the on-going work of PAS will be introduced in the presentation.

References

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Fleischmann Lecture: Karen Faulds

Multiplexed and Sensitive Bioanalysis using SERS and SESORS

***K. Faulds[1]**, K. Gracie, S. Mabbott[1], H. Kearns[1], L.E. Jamieson[1], F. Nicolson[1], A. Kapara[1], D. Graham[1], R. Goodacre[2]*

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Abstract:

Surface enhanced Raman scattering (SERS) was first demonstrated by Fleischmann in 1974[1] and since then it has developed into a highly researched technique with several advantages over competitive approaches in terms of improved sensitivity and multiplexing. However, the lack of quantitative data relating to real samples has prevented more widespread adoption of the technique. Detection of specific biomolecules is central to modern biology and to medical diagnostics where identification of a particular disease is based on biomarker identification. Many methods exist and fluorescence spectroscopy dominates the optical detection technologies employed with different assay formats. We have made great progress in the development of SERS as a quantitative analytical method, in particular for the detection of biomolecules. Another advantage of SERS over existing detection techniques is that of the ability to multiplex which is limited when using techniques such as fluorescence. A focus of our research is developing multiplexed bioassays using SERS to allow the simultaneous measurement of multiple species in one measurement.

During this presentation we will demonstrate the development of new bioanalytical assays based upon SERS which have been used successfully for the detection of bacterial pathogens using modified SERS active probes.[2] Biomolecule functionalised nanoparticles have been designed to give a specific SERS response resulting in discernible differences in the SERS which can be correlated to the presence of specific pathogens. In this presentation the simultaneous detection and quantitation of 3 pathogens within a multiplex sample will be demonstrated.[3] Also presented will be our recently published work on the use of nanoparticles functionalised with resonant Raman reporter molecule for the visualisation of a 3D breast cancer tumour models using Spatially Offset Raman (SORS) combined with SERRS (SESORRS).[4]

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Schwäbisch Gmünd Prize

Catalytic metal coatings on porous and 3D printed electrodes for electrochemical flow reactors: Prospects and the role of X-ray computed tomography

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Abstract

Electrochemical flow reactors have found important applications in electrosynthesis, energy storage and conversion, destruction of hazardous compounds and water treatment technology. Their performance can be improved by implementing porous electrodes, which provide them with a higher electrode surface area and an enhanced mass transport coefficient, in comparison to classical planar electrodes. This presentation describes the preparation and analysis of platinized titanium electrodes for cerium-based redox flow batteries. The platinum coatings on micromesh and felt substrates were obtained through galvanostatic and potentiostatic electrodeposition in an alkaline bath. Surface morphology and deposit distribution within the porous materials were studied using SEM and X-ray computed tomography, while their surface area was estimated from their charge transfer current ratio versus a planar electrode for a reaction of interest. Recent advances on 3D printed porous electrodes are also discussed, taking as example the combined characterization of surface area and mass transport for two different nickel-coated stainless steel structures. The coatings on these laser-sintered substrates were prepared by electrodeposition and electroless deposition. 3D printing techniques offer the possibility of creating porous electrodes by design, aiming to develop more efficient electrochemical flow reactors. Overall, the present work showcases the opportunities and challenges in the preparation of functional coatings using parallel plane electrochemical flow cells.

Sponsors

Many thanks to our generous sponsors for supporting this conference:

Oral presentations at a glance

Energy and Environmental

EE1	Antonio Maia Chaves Neto	Heavy metals nanofiltration using nanotube and electric field by molecular dynamics
EE2	Mohamed Nasreldin	Microstructured electrodes supported on serpentine interconnects for stretchable electronics
EE3	Alexander Wallace	The Effects of Ultrasound on the Electro-Oxidation of Sulfate Solutions at Low pH
EE4	Aranzazu Carmona Orbezo	Performance Optimization of Capacitive Deionization by Potentiostatic Analysis
EE5	Declan Bryans	Surface Treatment of Carbon Felt Electrodes and the Associated Impacts
EE6	Alexander Murray	Electronic tuning and applications of organic redox active charge carriers
EE7	Eileen Yu	Microbial electrosynthesis (MES) for Conversion of CO2 to Fuels and Chemicals
EE8	Georgia Orton	Towards [FeFe]-Hydrogenase biomimics for H_2 oxidation
EE9	Cameron Bentley	Correlative Electrochemical Microscopy of Li-Ion (De)intercalation at a Series of Individual $LiMn_2O_4$ Particles
EE10	Edmund Dickinson	Theoretical insights into optimal cell configuration for reliable three-electrode impedance measurements in Li-ion cells
EE11	Ben Craig	DFT modelling of single chains of PEDOT investigating charge storage behaviour in the Al-PEDOT battery
EE12	Ravi Kumar	Protic Ionic liquid Electrolytes for Water Electrolysis
EE13	Andrew Wain	Active site manipulation in MoS_2 hydrogen evolution catalysts by transition metal ion doping

EE14	Samuel Perry	Polymers with Intrinsic Microporosity (PIMs) for Carbon Dioxide Reduction at Gas Diffusion Electrodes
EE15	Liang Wu	Electrochemical oxidation of ammonia to renewable hydrogen in an electrochemical flow reactor
EE16	Nourhan Mohamed	Anodic oxidation of nickel foam in molten KOH for supercapacitor applications: The role of overpotential on capacity and stability
EE17	Pawin Iamprasertkun	Capacitance of Graphite/Electrolyte Interfaces
EE18	Dhrubajyoti Bhattacharjya	Effect of electrode processing and cell assembly on the performance of supercapacitor in prototype pouch cell format

Materials and Processes

MP1	Vivek Padmanabhan	Tailoring the Stability of Lithium-Oxygen Battery Electrolytes with the Use of Redox Mediators
MP2	Marie-Laure Doche	Recent developments in electropolishing of additively manufactured 316L stainless steel
MP3	Santiago Pinate	Electrocodeposition of nano-SiC particles under an adapted Pulse-reverse waveform
MP4	Eden May Dela Pena	Research Efforts on the Application of Ionic Liquid Technology for Surface Modification of Metals at the University of the Philippines
MP5	Ruoyu Xu	Nanoporous carbon: liquid-free synthesis and geometry dependent catalytic performance
MP6	Nicola Comisso	Preparation of electrocatalysts for OER via gas bubble templated deposition and galvanic displacement steps: New evidences on secondary oxide growth

MP7	Ignacio Tudela	Sonoelectrochemical degradation of chlorinated organic pollutants in water: 1 plus 1 equals 3?
MP8	Jean-Yves Hihn	Sonoelectrochemistry: reactor characterization tool and for electrochemical processes accelerator
MP9	Lucia Lain Amador	Copper electroformed getter-coated vacuum chambers for particle accelerators: from concept to development
MP10	Donghoon Kim	Enhancing magnetoelectric coupling for the efficient magnetic field induced electrochemical reactions
MP11	Sotiri Mavrikis	Carbon-based Materials for Anodic H_2O_2 Electrosynthesis
MPK1	**Luis Fernando Arenas**	**Catalytic metal coatings on porous and 3D printed electrodes for electrochemical flow reactors: Prospects and the role of X-ray computed tomography**
MP12	Konrad Eiler	Electrochemical synthesis of magnetic mesoporous Ni-Pt alloy thin films for hydrogen evolution reaction
MP13	Enrico Daviddi	Revealing spatially-dependent electron-transfer kinetics within a phase-separated conductive polymer blend at the nanoscale
MP14	Emily R. Cross	Electrochemical Gels for Biological Applications
MP15	Leigh Aldous	Thermogalvanic cells: Progress in both fundamental understanding and application
MP16	Sabrina Patricia Rosoiu	Electrodeposition of Ni-Sn alloys and Ni-Sn / rGO composite coatings from deep eutectic solvents and their physicochemical characterization

Physical and Fundamental

PF1	Angel Cuesta	The potential profile across the electrode-electrolyte interface: cation size effects and implications for CO_2 electrocatalysis
PF2	Sarah Horswell	The effect of hydrogen bonding capacity on lipid bilayer structure and function
PF3	Yvonne Grunder	Probing the charge distribution at the electrochemical interface
PF4	Gilles Moehl	Following the formation of Electrochemically Assisted Self Assembled silica films in real time by in situ Grazing Incidence Small Angle X-ray Scattering
PF5	Reena Saxena	Modified Multiwall Carbon Nanotubes (MWCNT) based Electrochemical sensor for Thallium in water
PF6	Anthony Lucio	Optimisation of boron-doped diamond electrodes for the quantitative detection of free chlorine species at high and low concentrations
PF7	Albert Schulte	Greening analytical voltammetry through electrochemical cell miniaturization
PF8	Rhushabh Maugi	Aptamers and Peptides – Opening new Libraries
PF9	Jacqueline Hicks	Tracking Ultrashort Carbon Nanotube Wireless Electrodes Within NG108 Cells
PF10	Bo Hou	Chemically Encoded Self-Organized Quantum Chain Supracrystals with Exceptional Charge and Ion Transport Properties
PF11	Anthony Betts	Detection of Non-Steroidal Anti-Inflammatory Drugs Utilising Cerium Dioxide Nanoparticles Deposited on Modified Screen Printed Electrodes

PFK1	**Guy Denuault**	**Studies of the influence of molecular oxygen on the formation and reduction of oxides on Pt electrodes**
PF12	Ioannis Katsounaros	Monitoring products of electrochemical reactions in real time
PF13	Haoliang Huang	The role of SnO_2 in the bifunctional mechanism of CO oxidation at Pt-SnO_2 electrocatalyst
PF14	Simon Reeves	Fundamental Electrochemistry of P-Block Halometallates in Non-Aqueous Solvents
PF15	Aruna Ivaturi	Non-invasive Non-Enzymatic Electrochemical Glucose Sensors based on Metal Oxide Nanostructures
PF16	Caoimhe Robinson	Label-free Electrochemical Immunosensor for the Detection of IgG in Calf Serum

Corrosion Science

C1	Koushik Bangalore Gangadharacharya	Thin electrolyte thickness measurements for atmospheric corrosion modelling
C2	Liya Guo	The corrosion behaviour of magnetocaloric alloys under magnetic field conditions
C3	Yishuang Yang	Study on ion penetration within polymeric binder by ion selective electrode
C4	Chinmay Pardeshi	Calibration of a Pitting Corrosion Simulation Model using Pit Population Data obtained from White Light Interferometry
C5	Amelia Langley	Chaotic Copper Corrosion: The Influence of Dissolved Gas on the Anodic Passivation of Copper in Model Seawater
C6	Lukas Korcak	Introducing new electrolyte for copper plating with aluminium

C7	Mariana Folena	Evaluation of the role of acetic acid in CO_2 Top of line Corrosion using real-time corrosion measurements
C8	Amir Shamsa	Influence of Ca^{2+} ions on corrosion product formation kinetics and characteristics in CO_2 environments
C9	Clive Harrison	Electrochemical Corrosion Monitoring in the Nuclear Industry
C10	Sarah Leeds	Monitoring corrosion protection of pipelines utilizing the main survey techniques
C11	Hunter Thomson	Chemical Qualification of Corrosion Inhibitors in the Oil & Gas Industry: Impact of Test Approaches on Performance during Laboratory Screening
C12	Paul Lambert	Long-Term Corrosion Monitoring of Steel and Reinforced Concrete Infrastructure
C13	Steve Paterson	Steve Paterson: Paul McIntyre award recipient talk
C14	David Kumar	The study of hot water corrosion for fusion reactor cooling circuits
C15	Ivan Spajić	Atomic layer deposition thin films from Al_2O_3 and HfO_2 as protection of commercially pure titanium for biomedical applications
C16	Salil Sainis	Influence of size and distribution of intermetallic particles in Al-Si cast alloys on the cerium conversion coating deposition
C17	Jessica Moulton	Modelling the Behaviour of Aluminium Flakes in Marine Coatings Through the Use of Agar Gels
C18	Alvaro Sanchez Araujo	Mechanisms of life enhancement by laser shock peening surface treatment of 7XXX aluminium alloys
C19	Isehaq Al-Nafai	Electrochemical Study of the Effects of Adding Pigments to Zinc-Rich Coatings
C20	Katarzyna Rzeszutek	Reducing the zinc content in protective marine coatings