Acta*Chimica*Slovenica

Issue dedicated to the Regional Symposium on Electrochemistry - South East Europe

The Regional Symposium on Electrochemistry – South East Europe (RSE-SEE) is the largest and most important of the series of regional conferences in the field of electrochemistry for Southeast and Central Europe. This series has been supported by the International Society of Electrochemistry. RSE-SEE was initiated in 2007 by nine national societies from Bulgaria, Czech Republic, Croatia, Hungary, Romania, Serbia, Macedonia and Slovenia. This 4th RSE-SEE held from 26 to 30 May 2013 in Ljubljana was co-organised by the Jožef Stefan Institute, the National Institute of Chemistry and the Centre of Excellence for Low Carbon Technologies. The Scientific and Organising Committees comprised 23 established scientists from the SEE countries. This year the symposium attracted such world-class plenary speakers as Patrik Schmuki (Germany), Philippe Marcus (France), Jürgen Fleig (Austria), Miroslav Fojta (Czech Republic) and Nenad M. Marković (USA). The programme also contained nine excellent key-note presentations, 61 contributed talks and almost 90 posters. The four days of the main symposium attracted more than 200 participants from more than 20 countries.

Another strong tradition of the series was continued in the Symposium – a special one-day pre-symposium event devoted to the contributions of students. The »Student RSE-SEE« started with four invited review lectures given by already established Slovenian scientists of the younger generation – Robert Dominko, Anton Kokalj, Samo Hočevar and Aleš Iglič. These were followed by a range of exciting talks presented by selected young scientists coming from the SEE region.

The RSE-SEE series traditionally covers all aspects of electrochemistry. This year the main focus was on both traditional and emerging research areas of electrochemistry. Diverse and stimulating lectures were presented, proving once again that electrochemistry provides the basis for a broad spectrum of applications that are important in a sustainable modern society. This issue of Acta Chimica Slovenica contains 19 invited papers covering the topics presented at the conference. All the papers have been subjected to the regular peer-review procedure prescribed by ACSi. They are divided into four categories: General electrochemistry and Physical Chemistry, Energy conversion and storage devices, Corrosion, passivation and anodic films, and Electrochemical synthesis, deposition, electrolysis and engineering.

The first session comprises five papers devoted to problems in physical and general electrochemistry. Liposomes encapsulating nanoparticles (NPs) with magnetic properties, termed "magnetoliposomes", have attracted great interest in the recent past due to their potential biomedical applications, especially in targeted drug delivery. Santosh *et al.* emphasised that the interactions of Fe_2O_3 NPs with the cell membrane can alter a bilayer's physical properties, such as fluidity, phase transition temperature and permeability. The accumulation of Ca^{2+} ions in the region of the negatively charged phosphate groups in the lipid head groups affects bilayer fluidity. The rotating ring-disc electrode (RRDE) is a very powerful tool for studying homogeneous and heterogeneous kinetics. Vesztergom *et al.* used a new digital simulation approach to the RRDE system, based on classical finite-element methods. This was used to model charge transfer and mass transfer processes at the ring and disc, together with the homogeneous chemical reactions taking place in the solution. The contribution by Láng and Ujvári addresses ruthenium which is very important in electrocatalysis and fuel cells. It has been widely assumed that adsorption of perchlorate ions on noble metal electrodes is very weak and that their reduction does not take place. The authors presented evidence that Ru is also an excellent catalyst for the reduction of perchlorate ions to Cl^-, i.e. chloride ions can easily be formed during experiments and may significantly influence the electrocatalytic activity of ruthenium.

A classical problem in physical chemistry was investigated by Gongadze and Iglič. Most of electric double layer (EDL) models are based on the concept that the relative permittivity in the whole system is constant. It is shown that permittivity of the Stern layer depends strongly on the magnitude of the surface charge density. In the field of organic electrochemistry, Mendekovich *et al.* studied the reactions of electroreduction of the Henry reaction product (1-phenyl-2-nitroethanol, PNE) in a solution of 0.1 M Bu_4NClO_4 in acetonitrile. The Henry reaction, the base-catalyzed formation of β-nitro alcohols from nitroalkanes and carbonyl compounds, is one of the general methods for carbon–carbon bond formation.

In the second session, six papers devoted to energy conversion and storage devices are presented. Among the former, solid oxide fuel cells (SOFC) and proton-exchange membrane fuel cells (PEMFC) are still at the centre of many investigations. Stoynov *et al.* here use a variant of impedance spectroscopy – permittivity spectroscopy – and demonstrate the phenomenon of gigantic enhancement of the effective capacitance. The phenomenon is explained by the formation of organized dipole structures, also known as dipole micelles. Interestingly, a similar phenomenon has been observed in completely different systems, such as lubricating oils. As regards PEMFC, one of the most burning problems is still the degradation of the catalyst under operating conditions. In their contribution, Hodnik *et al.* present new findings about the degradation mechanism of a commercial platinum fuel cell catalyst. The new insight was possible due to the use of a special, laboratory-invented, identical location scanning electron microscopy (IL-SEM). In contrast, Bozzini *et al.* report the synthesis of a novel electrocatalyst for the oxidation reduction reaction (ORR). As the substrate, they use graphene

instead of the conventional carbon blacks. Graphene is then decorated by Co/CoO active particles using electrodeposition. The exciting observations using micro-X-ray absorption spectroscopy and X-ray fluorescence mapping were presented. Tavčar *et al.* developed a new, very accurate and computationally efficient method. It offers a significant reduction in computational times and can be seen as a very promising, stand-alone fuel cell model for system level simulations. Catalysts are of course also important in many other fields. Ma *et al.* report the use of Ru-oligometalate catalysts for water oxidation. They assess the predictive power and capability of classical interatomic potentials for describing the atomistic structure of a fully inorganic water-oxidation catalyst in the gas phase and in solution. The only contribution on storage devices is that by Sopčić *et al.* who discuss several critical factors that influence the power and energy capability of RuO_2 supercapacitors.

Due to the high costs and related environmental problems associated with corrosion processes in industry and everyday life, the study of corrosion protection is always relevant and stimulates the search for new alternatives and solutions. The third session comprises five papers devoted to ways of protection against corrosion through experimental and numerical modelling and analysis. Plasma electrolytic oxidation (PEO) is a processing technique in which the surfaces of metals and their alloys are converted into oxide coatings through anodization of the metal above the dielectric breakdown voltage. Bajat *et al.* performed PEO on aluminium in sodium tungstate solution, with and without the addition of zirconium. The presence of Zr increased the stability of oxide coatings to corrosion by generating both high compactness and thickness of oxide layers consisting of Al, W, and Zr oxides. Zirconium oxide is also studied by Gomez-Sanchez *et al.*, but from another point of view. The steep increase in demand for medical implants requires materials of high chemical resistance in biological environments. Due to good mechanical properties and biocompatibility zirconium and some of its alloys are highly suitable for biomedical applications. Their osseointegrative ability and corrosion resistance can be improved by anodisation in phosphate containing electrolytes. Another material is considered for biomedical applications by Katić and Metikoš-Huković. Nitinol, nearly equiatomic alloy of titanium and nickel, exhibits two unique properties – superelasticity and a shape memory effect. In order to enhance its biocompatibility, a passive oxide film was formed by oxidation of Nitinol in acetic acid. Mott-Schottky analysis has been carried out to investigate the electronic properties of the oxide film, taking account of the frequency dispersion. The passive film on Nitinol behaves as a highly doped n-type semiconductor and exhibits high corrosion resistance.

The application of self-assembled monolayers (SAMs) in protecting metals against corrosion has raised enormous interest. Their protective effect is explained mainly by formation of a dense organic layer of well-defined structure that blocks the active spots on the metal surface. SAMs layers may replace traditional corrosion inhibitors dissolved in corrosive media. Marušić *et al.* examine the possibility of cupronickel (Cu-30Ni) protection in chloride media by SAMs of stearic acid (SA). Effective and long-lasting protection was achieved by oxidation of CuNi at 80 °C prior to immersion in SA solution and followed by a drying step at 50 °C.

Quantum chemical calculations have become very fashionable in studies of corrosion inhibition. There have been several attempts to explicitly model the inhibitor–surface interaction, in which materials were represented by metal ion, atom, cluster, or slab models. Kokalj examines the use of various models for representing oxidized metal surfaces. Imidazole inhibitor, MgO surface and solvated Mg^{2+} ions are together considered as a representative model system by means of density-functional-theory calculation.

The fourth session on electrochemical synthesis and functional materials comprises three papers dealing with electrochemically active polymers and electrochemically modified graphite. After more than three decades, electrochemically active polymeric films are still in the foreground of research, due to their applications in the fields of energy storage, electrocatalysis, organic electrochemistry, etc. There are still controversial issues concerning the structure of indole and indole derivatives. Broda and Inzelt studied the electropolymerization of 5-aminoindole on platinum electrodes in acidic media, making use of the electrochemical quartz crystal nanobalance. Electrooxidation of 5-aminoindole leads to the formation of uniform, yellow, electrochemically active polymeric films. At higher positive potentials, further oxidation takes place, resulting in various blue-purple, indigo-type materials that remain attached to the metal surface but show decreased or zero redox activity. Although conducting polymers show remarkable features in several fields, their industrial application usually requires the improvement of certain parameters such as conductivity, capacitance and stability. This can be achieved by forming composites, such as by embedding inorganic (nano)particles in the organic matrix. Cobalt-ferrite ($CoFe_2O_4$) is a spinel (or inverse spinel) structured, ferromagnetic oxide. Due to its potential catalytic application and tuneable magnetic properties it is gaining more and more attention. Endrődi *et al.* develop a strategy for conducting polymer based nanocomposite formation through the deposition of cobalt-ferrite ($CoFe_2O_4$) containing poly(3,4-ethylenedioxythiophene) (PEDOT). The photoelectrocatalytic performance of the nanocomposite was demonstrated in the electrooxidation reaction of dopamine. Magdić *et al.* explore the use of electrochemical impedance spectroscopy for characterizing electrochemically modified graphite electrodes in sulphuric acid solution. The existance of porous electrodes, involving two different electrolyte diffusion paths, would suggest the existence of two classes of pores.

We are grateful to all our colleagues for their diverse, high-quality presentations at the symposium. We also thank the chairpersons for leading the stimulating discussions, and the members of the Scientific and Organizing Committees for their fruitful cooperation. The devotion and hard work of the members of the local organizing committee ensured that the conference proceeded smoothly. We thank the Editor of Acta Chimica Slovenica and the Editorial board for offering us the possibility to publish this special issue devoted to the conference and for their help during the submission, revision and editing processes. The critical part of this process was carried out by the reviewers who remain invisible but whose role is invaluable. For us, as the conference chairs, the organization was a responsible task, although most pleasant due to the relaxing atmosphere and warm cordiality of the numerous participants whom we have known for many years and of the new participants we met on this occasion. With the motto of our conference being "*The best in electrochemistry, with the most visible researchers and latest discoveries*" we wish you many new scientific ideas, but also friendly and relaxing gatherings with colleagues in future. We believe that the friendly spirit of this conference, combined with its high scientific level, will continue.

Sincerely, ***Ingrid Milošev***
and ***Miran Gaberšček***
Guest editors of the special issue
and co-chairs of the 4th RSE-SEE

Graphical Contents