# Preface

The series *Modern Aspects of Electrochemistry* has presented new developments in Electrochemistry since its inception in the early 1950s. This prestigious series contains works of many distinguished electrochemists worldwide including those of the series founders, Professors John O'M. Bockris and Brian E. Conway. The vision of Professors Bockris and Conway continues to achieve greatness with its 57th volume thanks to Springer and Dr. Kenneth Howell. I would especially like to point out that I was blessed with opportunities to study, work with, and collaborate with Professors Conway and Bockris. I owe a great deal to these two fine individuals for all I have learnt in the field of electrochemistry. Professors Bockris and Conway collaborated with many electrochemistry groups around the globe. In this way, Professors Bockris and Conway significantly influenced many electrochemists and developments in the electrochemical science and technology. I would especially like to mention the contributions of my former teacher, Professor Konstantin I. Popov, and his coworkers, who in spite of very limited equipment and finances are still achieving first class results.

This volume of *Modern Aspects of Electrochemistry* is devoted to Professors John O'M. Bockris and Brian E. Conway. Although Professor Brian E. Conway passed away in 2005 and Professor John O'M. Bockris, just recently, in July of 2013, their vision continues and will continue in the future. Significant contributions to this volume have come from individuals who were in one or another way influenced by these fine minds.

Chapter 1 by Jović et al. describes the electrodeposition of alloys and composite materials. After a historical overview of the early work, the chapter discusses the conditions for the electrodeposition of alloys from a thermodynamic point of view. The narrative then further explores the characterization of the electrodeposited alloys by electrochemical techniques. Anodic linear sweep voltammetry for the characterization of the electrodeposited alloys, e.g., eutectic, solid solution, and alloys with intermediate phases or intermetallic compounds is described and referenced in detail. In addition, the results of the analysis of electrodeposited alloys by the anodic sweep voltammetry are compared to those obtained by the X-ray diffraction. Finally, the chapter describes electrodeposition of composite materials and their mechanical and electrical properties. Important discussion is devoted to the electrodeposition of Ni–$MoO_2$ composite coatings as cathodes for hydrogen evolution in industrial electrolysis.

In Chap. 2, Nikolić and Popov discuss the mechanistic aspects of lead electrodeposition. Electrodeposition of lead is characterized by a relatively high exchange current densities. For a while, it was generally accepted that the electrodeposition of lead proceeds in the whole range of overpotentials and that it is diffusion controlled. The experimental results and discussion in this chapter show that electrodeposition of lead may proceed under the conditions of pure ohmic or mixed ohmic-diffusion control. The conditions for lead electrodeposition are influenced by the concentration of Pb(II) in the solution. At higher concentrations of Pb(II) in the solution, electrodeposition of lead is completely under ohmic control. The surface morphology of the electrodeposited lead is determined by the conditions of electrodeposition. While under ohmic control well-defined single crystals of lead are produced, elecetrodeposition under mixed ohmic-diffusion control leads to the formation of dendritic deposits. The formation of different shapes of dendrites of lead during the electrodeposition is further attributed to the composition of the electrolytes used in the experiments. The primary type of dendrites is produced from the simple electrolytes, while the secondary type is formed from *complexed* solutions.

In Chap. 3, Mišković-Stanković discuses the electrophoretic deposition of ceramic materials onto metal surfaces. Ceramic coatings may be useful as anticorrosion surfaces or in biomedical applications as implants. Materials presented in this chapter include alumina, boehmite, monetite, brushite, hydroxyapatite, and their combination with silver and/or lignin. The effects of the parameters of electrochemical deposition on the thickness, morphology, and structure of the deposited ceramic coatings are discussed in this chapter. Various instrumental methods are used to describe the properties of electrodeposited ceramic coatings.

Chapter 4 by Tsui and Zangari reviews the fundamentals of the electrodeposition of metal oxides for the energy conversion and storage technologies. Electrochemical growth of oxide materials and methods to control their composition, surface morphology, and crystal structure in relation to the applications for the energy conversion are discussed. The materials examined in this chapter include ZnO for solar cells, $Cu_2O$ for photovoltaic and photoelectrochemical systems, $\alpha$-$Fe_2O_3$ for photoelectrochemical water splitting, and $MnO_2$ for the supercacitor energy storage.

Chapter 5 by Stojadinović et al. is devoted to the anodization of aluminum and more particularly to an interesting phenomenon—namely, luminescence—occurring during this process. While the anodization of aluminum has been investigated for quite some time, little or no attention has been paid to the occurrence of so-called galvanoluminescence, an emission of weak optical radiation, mostly in the visible spectrum. The nature of the galvanoluminescence depends on the electrolytes used in the process, surface pretreatment, and anodizing conditions. As such, the galvanoluminescent methods are recommended for use in the determination of the oxide film thickness, growth rate, refraction index, optical constants of alumina, etc. Anodization of aluminum above the breakdown voltage leads to the formation of plasma as indicated by the presence of sparks on the surface, accompanied by the simultaneous gas evolution. As a consequence, the total luminescence increases. The spectroscopy analysis of plasma allows the determination of electron temperature and electron number density.

In Chap. 6, Cadian et al. analyze the electrochemical aspects of chemical and mechanical polishing. This process is widely used in the semiconductor manufacturing in order to generate complex three-dimensional geometries. A successful polishing of metals is based on the formation of a passive surface film. Chemical mechanical polishing performed on both tungsten and copper and the electrochemical interactions with the polishing slurry are discussed in this chapter. Electrochemical processes that lead to undesirable phenomena such as pitting, etching of the metal surface, galvanic corrosion, and re-deposition of material onto the polished surface are described in detail.

Chapter 7 by Djokić and Magagnin reviews the surface treatments prior to metallization of semiconductors, ceramics, and polymers. Classical and recently developed methods such as treatment of the ceramic and polymer surfaces with Pd (II) and Ag(I), as well as galvanic displacement reactions for the case of semiconductors, are discussed. Metallization of nonconductive surfaces is very important for many industrial applications.

I sincerely hope that this volume of the *Modern Aspects of Electrochemistry* will bring to scientists, researchers, engineers, and students review chapters related to the latest findings in the field of electrodeposition and surface finishing, The ideas discussed will have significant import for electronics, aerospace, automotive, energy devices, and biomedical applications.

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