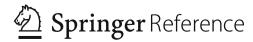
Handbook of Nanoelectrochemistry

Mahmood Aliofkhazraei Abdel Salam Hamdy Makhlouf Editors

Handbook of Nanoelectrochemistry

Electrochemical Synthesis Methods, Properties, and Characterization Techniques

With 753 Figures and 131 Tables



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Preface

Nowadays, human cannot still expand the frontiers of knowledge by having an unchanged usual view to the natural, chemical and biological processes. In order to develop and grow the human knowledge, it is necessary to see from different views and in various aspects. Looking from the large and broad scales such as the mapping of cities and countries with satellite, etc., give us the information which are unachievable by the normal vision. However, looking to the nature, from the perspective of micron and nanometer (at atomic scales) provides the information which can more easily discover the mystery of that phenomenon. What is now known as nanotechnology is becoming familiar and controlling many phenomena at the atomic and angstrom dimensions which is a difficult way with promising future and very amazing results. For instance, the recent progress in fabrication of carbon nanotubes, microelectronic chips, bimolecular engines, and nanomachines, nanosensors, microfilters and other cases have resulted in changes and developments in computers, electronics, aerospace, biochemistry, ecology, chemistry and other sciences. Electrochemistry beside the presence of powerful microscopic methods and electrodes with nanometer dimensions helped us for microstructural investigation and identification of nanostructured surfaces.

Nanotechnology has also contributed in developing and progressing of analytical electrochemistry which is very widespread scientific field. Any non-uniformity in the surfaces causes to the lack of repeatability in the obtaining of expected results. For example, information surrounding the surfaces, interfaces, corrosion, failure or abrasion of the surfaces, non-uniformity of the surfaces, recognition of the existed components in the surfaces and the degree of their oxidation are much more necessitated to study the processes. This vital information can be obtained by nanotechnology, and different microscopic techniques have been improved and developed in order to analyze the surfaces at atomic scales.

Electrochemical deposition of the metals is an ancient art which is one of the primary processes in the protection using nanosized materials. Electrochemical deposition, electroless deposition and substitution reaction which are used for the deposition of metallic alloys and metallic composite materials, taking advantage of the electrochemical reactions. Multilayered thin film, nanowires, nanowires with

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nanometer layers, nanotubes, nanoparticles located in the metallic matrix and nanoparticles containing membranes can be fabricated by nanoelectrochemistry. The topics covered in this field of science are very broad. The progress in nanoelectrochemistry increased sharply during the recent years. As a result, this handbook aims to gather different aspects of nanoelectrochemistry beside its advances.

The editors of this handbook would like to appreciate all of contributors to this handbook and thank them for their hard work, patience during preparation of this handbook and also their high quality chapters. We wish publishing of this handbook will help all researchers to benefit from this collection and further progress of nanoelectrochemistry.

Summer 2015

Mahmood Aliofkhazraei Abdel Salam Hamdy Makhlouf

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Dr. Mahmood Aliofkhazraei is assistant professor in materials engineering department at Tarbiat Modares University. Dr. Aliofkhazraei's research interests include nanotechnology and its use in surface and corrosion science. One of his main interests is plasma electrolysis, an area in which he published more than 40 papers and a book. In total, he has published more than 12 books and 90 journal papers. He has given

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Prof. Makhlouf is a multiple-award winner for his academic excellence: He received several prestigious awards in **Germany** (Humboldt Research Award for Experienced Scientists at Max Planck Institute); **USA** (Fulbright Visiting Scholar, NSF Fellow, and Department of Energy Fellow); **Belgium** (Belgian Federal Science Research Fellowship); **Arab League** (Arab Youth Excellence Award in Innovation 2013); **Jordan** (Abdul Hameed Shoman Award in Engineering Science 2012); **Egypt** (National Prize of Egypt in Advanced Science and Technology 2006; Egyptian Prize of Excellence in Surface Technology and Corrosion 2006; and Egyptian Prize of Excellence and Innovation in Materials Science and their Applications 2009); and **Palestine** (An-Najah Prize for Research 2014). Prof. Makhlouf's biography was selected to be included in *Who's Who in the World*® 2015, 2007, and 2006.

Prof. Makhlouf is a persistent journal reviewer, advisor, and judge of the work of his peers. He is a referee for over 30 international journals of a high caliber, and a continued board member of over 20 journals. He is also an experienced editor with board titles at journals published by Springer and Elsevier, an expert evaluator for the EU's FP7, with an estimated budget of over €50.521 billion, DAAD and German Aerospace Center, the US Fulbright Commission, the Qatar National Research Fund, the Kuwait Foundation for the Advancement of Sciences, and a consultant at Innosquared GmbH, Germany. He is a reviewer/panelist for the NSF programs: Manufacturing Machines and Equipment, Materials Engineering and Processing, and CREST; with an estimated budget of over \$7.6 billion. He is a member of the advisory committee of Australia − EU initiative "Corrosion Matters" through the EU program H2020.

Prof. Makhlouf has organized and served as a head speaker at highly prestigious international symposiums and conferences over 30 times. His publication list (+170) includes studies and review papers authored in journals from top publishers. He is the editor of 12 books, 17 book chapters, and has 2 US patents. He supervised 11 Ph.D. and master's students, and 5 postdoctoral fellows.

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