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BOOK REVIEW

A. Eftekhari (Ed.): Nanostructured materials in electrochemistry

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The nano-craze following the bio-craze and presumably supplanted in the near future with something related to solar cells and renewable energy devices is already with us for some time. Typical dimensions at electrochemical interfaces have been known to be on the nanometre scale for some time also. Nevertheless—a fresh look from a new angle—even when stimulated only or predominantly by easier access to funding—may provide new insights. Taking into account the time this new fashion has already spent in development a collection of reports dealing with various aspects of nanoscale features in electrochemical systems is a timely enterprise. From the reviewers' point of view (who dabbled himself many years ago in this field studying electrocatalysis at nanocrystalline metals with indeed fascinating results), there are three nano-related aspects meriting attention in electrochemistry:

- Electrodes smaller than microelectrodes: nano-sized electrodes,
- Materials with pore sizes or surface roughness in the nanometre range: nanoporous materials,
- Materials with a very high number of defects caused by extremely small crystallite sizes in almost amorphous or non-crystalline materials: nanocrystalline materials.

Obviously, the development into the nano-world is apparently only a more or less planned extension of miniaturisation beyond the micrometre scale. As already known from other areas of science and technology (e.g. the semiconductor industry), this development is more than a simple linear extension; frequently, it requires entirely new instruments, methods and models. In many cases size effects (like , e.g. in quantum dots) and the extremely large surface-to-volume ratios play major roles. Beyond top-down approaches like in high-energy ball-milling applied in the manufacturing of nanocrystalline materials, bottom-up approaches employing self-organisation or template-based processes may be helpful or even essential.

In the book reviewed here, contributions dealing mostly with the first and second aspects are collected. Anodising of aluminium as employed in the manufacturing of electrodes for electrolytic capacitors yields highly developed three-dimensional porous structures. Their optimisation regarding the electric properties of the capacitors is a daily challenge in the industry; the state of the art is reviewed extensively in the first chapter by G.D. Sulka. The second chapter by C.P. Oliveira et al. continues this topic somewhat and extends it by describing the use of porous alumina as a template in the galvanic preparation of nanowires. Somewhat surprising (but within this book not unexpectedly), not a single word is spent on the motivation for making nanowires; on their special properties only few words can be found. The third, short contribution by Y.H. Lanyon and D.W.M. Arrigan briefly reviews lithographic processes for making electrodes with nano-size dimensions. The fourth chapter returns to the nanowires. S. Valizadeh et al. focus on magnetic ones. A.C. Pereira et al. review nanowires and nanotubes as electrodes in small sensors highlighting the advantages of the high surface with well-defined morphological surface features. S. Nakanishi discusses oscillatory electrodeposition and their conceivable possibilities in the preparation of layered structures. O. Elkedim has a look at the corrosion behaviour of nanocrystalline materials: His conclusion is not surprising at all: Some of them corrode faster (although not explicitly stated, the average electrochemist arrives easily at this conclusion knowing that metal

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dissolution proceeds faster at grain boundaries and defects), some of them corrode more slowly and some of them behave exactly as their non-nanocrystalline relatives. Apparently, nobody looked at the effect of time: The reviewer noted in his own studies a fairly fast re-crystallisation with an associated loss of the special catalytic effect, and presumably this will be accompanied by changes in the corrosive behaviour also. In primary and secondary batteries, highly porous materials prepared by, e.g. compressing particulate active masses are of central importance. Unfortunately, volume changes associated with charging/discharging processes may affect the active masses negatively by, e.g. causing loss of electric contact between particle, and subsequently, increases of internal resistance and capacity fading. Numerous solutions have been proposed; many of them employ surface coating of active mass particles. From a fundamental point of view, this approach is reviewed by K. E. Aifanis and S.A. Hackney for active materials in lithium-ion batteries. M. Jurczyk and M. Nowak look at materials suitable for hydrogen storage in, e.g. nickel-metal hydride batteries. Beyond a fairly detailed review of this type of batteries (apparently somewhat displaced in this book), numerous examples of materials of nano-dimensional particle size are described. A. Du Pasquier provides a short overview of the use of nano-sized TiO_2 particles in energy conversion and storage, and finally, in two very short contributions, fullerenes, nanotubes and metal nanoparticles as possible components in sensors and analytical applications are dealt with.

The chapters are of considerably different scope and depth, thus not every electrochemist interested in nano-aspects in a particular field of electrochemistry will be satisfied. It is richly illustrated. Apparently, many figures have been scanned at rather low resolution from some original publication, some editing has been applied—but nevertheless many figures look like careless studies in grey scale. The hard-boiled electrochemist will read with some astonishment the foreword by R. Alkire. The overarching themes like “The Flow of Information between Individuals both Within and Amongst Disciplines” or “Collaborative Environment” this authors discovered in the chapters somehow escaped the reviewers eyes. Together with the rather voluptuous self-introduction of the editor, this is one of the more odd features of this book. The rapid progress in the application in particular of highly porous materials in batteries and capacitors will seriously limit the half-life of this book; nevertheless, the larger chapters provide an interesting approach to advanced materials. Those interested in catalysis will hardly be satisfied, and this applies to some extent also to those looking for nano-sized electrodes.