Books section



INDUSTRIAL ELECTROCHEMISTRY:- BY DEVEK PLETCHER CHAPMAN AND HALL. (1982) SECOND PRINTING (1984).

There are many periods of excitement in the field of Industrial Electrochemistry but never has there been anything to compare with that described in this text book. The editor has been successful in bringing out the various aspects of applied electrochemistry. Dr. Pletcher's basic idea is that the knowledge of electrochemistry is fundamentally an applied one. This book is realistic in practice, constructive in the pattern and conceptually sound. The book is well organised and provides a balanced overview of the present status of research in the Industrial Electrochemistry. This task is not certainly an easy one.

The book is divided into eleven chapters. The first chapter of this book is devoted to fundamental concepts of electrochemistry such as electron transfer, mass transport, adsorption, electrocatalysis and electroanalytical techniques.

Economy in optimizing electrolysis parameters and principles of various cell designs have been explained clearly in the second chapter. Concepts of sodium chloride electrolysis, developments of technologies for production of chlorine and potasium hydroxide are explained in depth in the third chapter. Electrowinning (Al,Na,Mg and Li) and electrorefining (Cu, Ni, Co, Pb, and Sn) are described in the fourth chapter. In the fifth chapter, the electrolytic preparation of inorganic compounds such as strong oxidizing agents ($KMnO_4$, $K_2Cr_2O_7$, $Na_2S_2O_8$ and F_2) metal oxides (MnO_2 and Cu_2O) and H_2 and / or O_2 by water electrolysis have been discussed in details and also their properties and uses. Various types of commercial water electolysers have been described.

Role of electrolysis in the preparation of organic compounds is explained in the sixth chapter.

Electroplating, anodizing and electrophoretic painting are described in detail in the seventh chapter. Various surface finishing techniques have also been described. The most important methods such as electroforming, electrochemical machining, electrochemical grinding and electrochemical deburring to manufacture metal articles or components which are difficult to produce by traditional mechanical workshop techniques are considered in the eighth chapter. The method of electrochemical etching in printed circuit boards have been effectively brought out.

Thermodynamics of corrosion, passivation kinetics, and the rate of corrosion reactions, and practical corrosion problems have been nicely delineated in the ninth chapter.

Concepts involved in batteries and fuel cells are comprehensively given in the tenth chapter.

The last chapter has dealt with the various aspects involved in water treatment and environemental protection.

References and text books covered in the section for further reading of each chapter are quite useful.

The topics covered in this book ranges from fundamental Electrochemistry to applied electrochemistry. The quality of printing and figures are upto the mark. I personally feel that this book should be more easily accessible to a larger number of industrial Electrochemists at a reasonable price. This book will be an asset to any library. Certainly most of the industrial Electrochemists and Chemical Engineers will be benefitted by this valuable book.

R. RAMESAM IPC., IISc, BANGALORE-12.

PLASTICS PRODUCTS DESIGN HAND-BOOK

PART B: PROCESSES AND DESIGN FOR PROCESSES
Ed. EDWARD MILLER, MARCEL DEKKER INC. (1983)
392 PAGES.

This book deals with various aspects on design and process which are common in plastics Industry. Various types of mouldings viz., compression/Transfer Moulding, Blow Moulding, Injection Moulding and Rotational Moulding with emphasis on product design and applications has been illustrated. It is felt that injection Moulding, which is extensively used in the Industry could have been dealth with little more elaborately. Another interesting application 'Pultrusion technology' -gives lot of scope for understanding process design of parts and economics of the product. Basic concepts have been illustrated effectivly with examples. Ultrasonic Assembly describes how to weld plastics and achieve complicated designed parts, which in normal course proves very costly, plating on plastic gives in brief various techniques available presently. Finally general recommendations for part design on various processes has been given with theory and applications. This book is very useful to persons who are not exposed to plastics Industry and can proceed on guidelines given on various processes.

G. Varadaraj Rao, ITI, Bangalore-16.

ADSORPTION ON AND SURFACE CHEMISTRY OF HYDROXYAPATITE

ED. DWARIKA N. MISRA, PLENUM PRESS NEW YORK (1984) 175 PAGES

This monograph on hydrxoyapatite, prime constituent of bone and teeth, has ten articles of which two are review articles on surface chemistry, solubility and interfacial properties of the hydroxyapatite. Only one paper discusses the adsorption and surface chemical characteristics in relation to zeta potential useful in mineral beneficiation by flotation. The rest of the papers of Dental hygine try to understand the mechanism of growth, dissolution and ashesion of tooth tissues studied through surfaces chemistry, adsorption, thermally stimulated exoemission and NMR. The book, usful in Dental research, is recommended as a reference book in all Dental Colleges.

U.B. Nayak, Metallurgy, IISc, Bangalore-12.

HIGH TEMPERATURE MATERIALS CORROSION IN COAL GASIFICATION ATMOSPHERES J.F. NORTON, ELESEVIER APPLIED SCIENCE PUBLISHERS, LONDON (1984).

The commission of European Communities at the joint Research centre Petter Establishment in the Netherlands organised seminar which is a part of a continuting series of events which the information centre of the high temperature materials programme organizes. This is with a view to encourage exchange of information and dissemination of scientific knowledge at a European Level.

Coal gasification to produce S.N.G. poses several high temperatures corrosion problem relating to materials of construction, because of the environment containing Corbon, Oxygen and Sulphur reacting with the materials. Considerable research and developmental activities at various centres are in progress to understand and resolve many of the corrosion problems. The book contains a record of this proceedings.

Four papers were presented at the symposium:the first two oriented towards basic understanding of the corrosion phenomena and the rest a review of the current state of the art in research and development at various centres seized with the problems of corrosion.

The first paper by Prof. P. Kofstad on high temperatures corrosion in single reactent gaseous environments is an excellant technical treatment of subject taking the typical cases of oxygen and other geasous corrodants. Various possible modes of attack of the basis metal behaviour of the surface film, and the role of various constituents in alloys intended for high temperature applications have been dealt with in a succint manner. The paper is a scholarly treatment of the subject. A long list of references enhances the value of the text.

The second paper on high temperature corrosion in complex multi reactant gaseous environements by H.J. Gralke complements the theoretical treatment given in the first paper. An understanding of the theymodynamic aspects of the corrosion of metallic surfaces when exposed to atmospheres, which may be oxidising, carbonizing or sulphidizing at high temperatures-will give an insight into the behaviour of various alloys in such cases and the possibility of improving the high temperature corrosion behaviour by an increase in the content of the alloying constituents like Cr, Al or Si as also addition of reactive metals like Y, Ce Hf, Nb or Ti in small quantities. The paper has been vary well written.

The third paper by J. Stringer on materials of construction in coal gasification systems deals with metallic materials. The paper discusses the experience in the US of behaviour of metallic materials in the gasification system. Two types of gasifiers, viz the BG. C-Lurgi and the Texiceo and Shell koppers entrained are described highlighting the conditions prevalent in each case. The effect of the constituents of the environment on the metallic component has been well documented with specific cases investigated. The problem of corrosion and erosion and the limitation with regard to the use of uncooled metallic materials have been discussed and a summary of selected failure analysis performed at A.N.L has been included in the appendix.

The next paper on high temperature corrosion metallic heat exchange materials in a fluidized bed gasifier by H.T. Schrothi W Schendler and H. Weber discusses the behaviour of the materials of construction in this system. The unique feature of the system in the gasifier is that heat is carried away from the case of nuclear reactor by a helium circuit at 950°C and transferred by means of a secondary circuit to the gas generator of the steam gasification system. The results of corrosion tests on different experimental alloys are discussed in the paper.

The last paper on Materials of construction in coal gasification systems deals with refractory and Ceramic materials by J.Stringer is complementary to his first part of metallic materials. The possible uses of various refractory materials to high temperature corrosion and their behaviour has been discussed. The metallic advantages gained by use of refractories to protect the metllic materials as well as the possible causes of deterioration of the refractories due to the reaction between the constituents in them and the environment are discussed drawing comparisons from conditions prevailing in typical blast furnace. Limited information available on structural ceramics is briefly mentioned. The role of Cr2 03, Al2 03 , MgO and other constituents in high temperature refractories in combating corrosion and erosion is discussed.

The book contains a wealth of information on the progress of Research and development in the design of large scale coal gasification. It is interesting to note that several institutions are engaged in active participation to arrive at a industrial scale production system. It is a valuable addition to the library of organizations involved in fuel research.

J. Balachandra, IISc, Bangalore-12.

STUDIES IN PHYSICAL AND THEORETICAL CHEMISTRY-29:

ELECTRONIC AND MOLECULAR STRUCTURE OF ELECTRODE-ELECTROLYTE INTERFACES-ED W.N. HANSEN, D.M. KOLB AND D.W.LYNCH, ELSEVIER (1983) 697 PAGES.

The proceedings of the international conferences on 'Electronic and Molecular Structure of Electrode-Electrolyte interfaces' held at Logan, UT, USA in July 1982, is now brought out as the twentyninth volume of the 'Studies in Physical and theoretical chemistry' series. The volume containing sixty-six important papers contributed by experts on diverse topics, along with the elegant summary of Yeager, is a precise pointer to the most recent advances (theoretical as well as experimental) made in attempting to comprehend the mysteries of the electrochemical interface at phenomenological, molecular and electronic, levels.

The papers have been classified into six different sub-sections although the classification is not entirely convincing. The largest sub-section on Surface Enhanced Raman Scattering (SERS) contains nine papers (93 pages). Eversince the first observation of SERS of Pyridine adsorbed on Ag electrodes, by Fleischmann et al, its profitable use as a probe to study the molecular states of the adsorbed species, has been under close scrutiny from several groups in the world. In the present volume, some of the recent finding regarding SERS patterns on Ag electrtodes of ionic and neutral species are presented viz, of halide ions, H_2O and pyridine (p 389), chloride and thiocynate ions (p 399), H_2O and D_2O at several temperatures (p415), pyridine and C O in ultrahigh vacuum (p425), N-methyl pyridinium cations in presence of anions under various pH (p437) piperidine and pyridine as a function of chloride ion concentration (p477), of EDTA (457) and of cobalt and ion tetrasulphonated phthalocyanines (p469). The current status of the theory of SERS is also reviewed by Furtak (p375). Although the mechanism (s) (as well as the nomenclature is as yet unsettled, the present experimental studies will, ultimately be of value in establishing the precise cause of the observed enhancement.

There are three preliminary papers concerning the application of the in-situ infrared spectroscopy viz. The adsorption of H_2on Pt and Rh (p481) using EMIRS and IRRAS, FTIR for in-situ recording of the electrogenerated intermediates and species adsorbed at the electrode surface (p 495) and study of HCOOH adsorption on Pt electrodes using EMIRS (p505). These in-situ optical techniques are aimed at obtaining molecular level insights about the structure of the charged interfaces. Other in-situ methods of limited applicability viz. the application of

Mossbauer spectroscopy to study passivation layers on iron (p 535) and the investigation of the electroreduction of naphthazarin derivatives using ESR spectroscopy (p 545) also find a place in the volume.

The fact that semiconductor electrolyte interface holds 'promise' towards the search for possible routes to solar energy conversion, has been well recongnised and in the present volume, eight papers deal with some aspects of this. After an expository article by Gerischer (p 553) concerning the role of semiconductor structure in photoelectrochemical processes, the application of pulses of ns width for studying the photocurrent and photopotential transients of n-type CdS and CdSe electrodes, is discussed by Harizon et al (p 571). Three papers deal with the study of passive films viz. Electron transfer reactions on metal-coated passive titanium (p 583), transient photocurrents at iron electrodes (p 593) and the application of a new surface EXAFS technique to determine the characteristics of passive iron films (p 603). The measurement of adsorption at single crystal n-MoSe surfaces using chronocoulometry (p 611), the investigation of dark nitrous oxide catalytic currents at p-GaAs aqueous solution interface (p 619) and the frequency dispersion in the impedance of schottky barriers for Tio surfaces (p629) have also been analysed. Together, these papers fill important gaps in our present understanding of photoelectrochemical processes.

Several techniques that are available to study solid vaccum interface can be used to investigate electrochemical interfaces by 'stripping off the bulk electrolyte from the electrode. Eversince this 'emersed double layer' was formulated by Hansen et al, the search has been on to elucidate the nature of the interface, using well known surface characterisation techniques such as ESCA and LEED. There are eight paper (p 111 to 228) dealing with various aspects of such ex-situ electrode surface studies. There are also papers devoted to chemically modified electrodes and electrocatalysis apart from the applicatioin of the spectroscopic techniques (visible-reflection) to the metal-electrolyte interfaces.

Amidst such a surfeit of experimental progress, the theortical developments have not been as rapid. There are fourteen papers devoted to the study of double layer structure vis a vis adsorption of solvent molecules and the following papers deserve special mention. The paper by Henderson et al (p291) continues the MSA study of the non/primitive model of the electrical double layer and prints out the short comings of the classical Gouy Chapman theory. The interesting analysis by Price et al (p347) takes into account the mobility of electrons at the metallic interface and interprets the linearity of the reciprocal of the compact layer differential capcitance C_M vs plots, for several metal surfaces. The jellium dipole model of Schmickler (p 19) explains the occurence of the capacitance hump on the positive side of the PZC with its shape and position, dependent essentially on the electron density of the metal. The paper by Badiali et al (p 25) attempts to account for the differences in capacitances of different metals by emphasizing the spill-over of metal electrons into the solution phase. With the European groups working overtime, it may not be long before we have more convincing approaches to double layer theories.

For the quality as well as the amount of information contained, the volume is an important source -book for those concerned with interfecial electrochemistry and by bringing out the proceedings in the 'Studies in physical and theoretical chemistry' series, the Editors have done well to impress upon the non-electrochemists, the difficulties and accomplishments of those working in an underestimated science-electrochemistry.

M.V. Sangara Narayanan, IISc, Bangalore-12

ELECTROANALYTICAL CHEMISTRY: VOL. 13: EDITED BY ALLEN J. BARD MARCEL DEKKER INC., NEW YORK AND BASEL (1984) 392 PAGES.

The thirteenth volume of the familiar Electroanalytical Chemistry series of Bard has three chapters.

The first chapter by Heineman, Hawkridge and Blount (113 pages, 192 references) on optically transparent electrodes (OTE) is a continuation of an earlier review by Kuwana and Winograd, on spectroelectrochemistry in the same series in 1974. Illustrated with extensive tables and figures, this chapter discusses briefly several types of OTE and the section on Optically Transparent Thin Layer Electrode (OTTLE) contains the analysis of various types of mechanisms of electrode processes (reversible, quasi reversible etc) with emphasis on organic systems. The progress made in the adsorption spectroelectrochemistry under semi-infinite diffusion conditions, since the appearence of the review by Kuwana et al, is also summarised. Finally, this chapter brings out some of the recent applications on oxidation of mercury, specific adsorption of anions and deposition of metals at mercury OTE etc. This stimulating chapter will obviously provide firm framework for further advancements in this interdisciplinary field.

The second chapter (76 pages: 24 references) by Stanley Pons is a concise and highly readable review on a new rapidly advancing topic 'Polynomil Approximation Techniques for differential Equations in Electrochemical Problems'. This chapter discusses in a brief manner, the motivation and methodology involved in finding improved methods of digital simulation to obtain approximate solutions to second order partial differential equations (PDE) in Electrochemistry. In an attempt to improve the procedure (or rather decrease the computer time), Carr and Whiting in 1977, provided a mole efficient algorithm based on the Method of Weighted Residuals (MWR). As illustrated in this chapter, MWR has an added advantage in that it is almost effortless to change the computer program as one goes from one type of mechanism to a completely different one.

The bibliography is impressive and the chapter is self-sufficient in that it can be read without periodical reference to the original literature. It is lucidly written and is easy to follow for any electrochemist with a marginal motivation towards numerical analysis techniques.

The third chapter by Royce Murray (178 pages: 363 references) is a critical and comprhensive review on Chemically Modified Electrodes (CME). The basic idea behind the development of CME is to immobilise a chemical on the electrode surface deliberately so that the electrode thereafter displays the chemical, electrical and optical characteristics of the immobilised molecule (s). This aspect is subsequently exploited in studies involving photosensitization, Photoanodic Corrosion scheme, electrocatalysis etc. The molecular systems are so chosen that they have special properties favouring the study of intramolecular and electrochemical electron transfer reactions. The review by Murray traces in a coherent manner the progress hitherto made in this direction.

After a brief survey of the experimental methods used to study the CME, the analysis of various metal oxide electrode surfaces with special reference to the modification by organosilanes is given. The investigations carried out on carbon electrodes modified by porphyrins and related systems vis a vis electron transfer are clearly elucidated. The progress on polymer film coated electrodes viz. Both the organic redox polymer electrodes (where the electroactive centres are part of the chain backbone) and ion exchange polymer electrode systems (where the ionoic redox species from the solution is confined to the electrode surface), is thoroughly analysed with a large number of illustrative examples. There is also brief mention on the development of chemically modified semiconductor electrodes with regard to photoanodic corrosion protection and photosensitization. In view of the substantial progress currently made in several laboratories, the dire need for this chapter is crystal-clear. Nevertheless, while reading this chapter, one is inclined to acknowledge the lack of parallel theoretical progress in the field of CME. Hopefully, the theoretical questions will soon be taken up for investigations in order to assist the experimentalists and thereby, for a more rapid progress of the field.

The high standard of the earlier volumes, is maintained in this as well, barring a few minor misprints in chapter 3. This well- brought out book should be found immensely useful to electrochemists.

M.V. Sangara Narayanan, IISc, Bangalore-12.