Materials Science of Concrete I

Edited by Jan P. Skalny
(American Ceramic Society, 1989),
332 pages
ISBN: 0-944904-01-7

New data and theories concerning the materials science of concrete are appearing so rapidly that it is difficult for researchers, manufacturers, or users to keep up with them. A series of reviews on selected topics is therefore timely, and Jan Skalny is to be congratulated on his initiative and on the content of this first volume of a projected series. It contains 11 articles by invited authors. All are authoritative, up to date, and well written.

The range of topics is somewhat wider than the title might imply. The opening article by Klemm reviews the history of cementitious materials, and it includes some little-known matter on the early history of the cement industry. Johansen treats aspects of the chemistry and physics of portland cement manufacture and relates them to the quality of the product. Brown outlines phase equilibria in the simpler systems relevant to the hydration of portland cement and discusses their significance for hydration mechanisms. Gartner and Gaidis review these mechanisms for calcium sulfate and tricalcium silicate from a more general standpoint, beginning with an account of the underlying physical chemistry. They promise a second part dealing with the more complex situation for cement.

Scrivener deals with the microstructures of anhydrous cement, cement paste and concrete, including discussions of their development and of the special features occurring at aggregate interfaces. Mindess reviews these and other interfaces in concrete from the complementary standpoint of their relations to mechanical properties. Parrott describes a procedure for modeling the development of concrete properties, based on the chemistry of the hydration reactions and the microstructure of the product.

In the first of two articles on microsilica (condensed silica fume), Roberts reviews the properties of this material and chemical and microstructural aspects of its use in concrete. Bentur deals with fiber-reinforced cementitious materials, largely from a physical standpoint, including composite theory and fracture mechanics. Rosenberg, Hansson and Andrade review mechanisms of corrosion of steel in concrete, beginning with an outline of the basic electrochemical background. Lastly, Frohnsdorff reviews developments in knowledge systems for the science and technology of concrete, defined as mechanisms for generating, storing, retrieving, processing, and transferring the relevant information.

Most of the articles are well referenced, a number between 50 and 100 being typical. Minor criticisms could be made of the typography, which shows irritating variations of blackness between different sections of almost every page, and of the index, which is so short and arbitrary in content as to be of little value. They do not, however, detract seriously from the value of the book, which is essential reading for every serious research worker and contains much that should help makers and users of cement or concrete. I look forward to seeing Volume II of the series.

Reviewer: H.F.W. Taylor, emeritus professor of inorganic chemistry, University of Aberdeen, Scotland, visiting professor at Imperial College, University of London, and author of a recent text on cement chemistry, carries out research in that field, mainly related to the hydration of portland and other cements.

Physics and Chemistry of Alkali Metal Adsorption Materials Science Monographs, Volume 57

Edited by H.P. Bonzel, A.M. Bradshaw, and G. Ertl
(Elsevier Science Publishers, 1989),
approximately 500 pages
ISBN: 0-444-88338-X

This collection of 33 papers is derived from the WE-Heraeus-Seminar on alkali metal adsorption held February 1989 in Bad Honnef, Germany. The book deals primarily with ultrahigh vacuum surface science studies but also contains contextual material from heterogeneous catalysis, matrix-isolated complexes, and semiconductor processing. As noted accurately by the editors, "Since many of the contributions have been written in review style...the resulting book not only presents a good overview of current activities in the area but also provides a useful reference work for the future." The book should prove useful both to surface scientists active in the field and to specialists in other areas seeking a quick but thorough and diverse entry into the unusually rich surface science literature of this topic.

Upon adsorption, the low ionization potential of alkali atoms leads to very strong interactions with metal and semiconductor substrates and with chemisorbed molecules. These strong interactions often involve substantial charge transfer and have important technological consequences, including the use of alkali prompters in (1) the heterogeneous catalysis of ammonia synthesis and the reduction of carbon monoxide to hydrocarbons, (2) the operation of low-temperature electron sources, and (3) possible improvements in control of the oxidation of semiconductors. The unusually strong interactions and spectacular spectroscopic effects accompanying alkali co-adsorption have made this area a fertile testing ground for improvements in the theory of chemisorption and the comparison of this theory with experiment.

The papers are grouped into five sections. The first, "Adsorption of Alkali Metals," contains theoretical and experimental treatments of the effects of alkali adsorption on the atomic-scale and electronic structures of metal single-crystal surfaces. The second section, "Co-adsorption of Alkali Metal and Molecules," covers interactions with co-adsorbed CO, NO, N_2, O_2, $Mo(CO)_6$, NH_3, H_2O, PF_3, H_2, CH_3OH, CO_2, C_2H_4 and CN^-. While surface scientists attuned to catalytic problems contributed most of the third section, "Significance of Alkali Additives in Heterogeneous Catalysis," the last paper also considers some of the bulk chemical properties important to practical catalytic systems. The fourth section, "Matrix-Isolated Alkali Metal-Molecule Complexes," provides a fascinating complement to the surface work. In these systems, electron-spin resonance can be used to clarify the issue of charge transfer, which is so difficult to approach spectroscopically at an interface. Surprising complexes with water or ammonia in which the alkali is an electron *acceptor* are presented, and the relationships between the matrix isolation and surface work are discussed. The final section, "Significance of Alkali Metals in Semiconductor Technology," primarily treats the effects of alkalis on the oxidation and nitridation of Si, GaAs, and InP.

As a reference, this book nicely documents both the consensus and the diversity within what might have been expected to be a narrow field. One source of disappointment in this volume dedicated to adsorbates which so grossly modify the surface charge distribution is the lack of comparisons to analogous electrochemical interfaces. Nevertheless, this book offers to the electrochemist, as to the catalytic chemist or semiconductor technologist, a key to a treasure trove of high-quality surface science information.

Reviewer: Frederick T. Wagner is a staff research scientist in the Physical Chemistry Department of the General Motors Research Laboratories, where his research seeks to characterize electrified interfaces in relation to corrosion and materials processing. □