Metal-Containing Polymeric Materials

C.U. Pittman, Jr., C.E. Carraher, Jr., M. Zeldin, J.E. Sheats, and B.M. Culbertson, eds.
(Plenum Press, New York, 1996)
528 pages, $125.00
ISBN 0-306-45295-2

Anyone who is first learning about polymers is presented with the typical examples which include polyethylene, polystyrene, and nylon. While the diversity exhibited by these polymers is impressive, the list is constrained by the presence of only carbon, hydrogen, nitrogen, and oxygen in these common polymers. Additional atoms to this list would greatly increase the variety of possible polymers. Silicon, sulfur, and the halogens are relatively common constituents of polymeric materials, but what about the rest of the elements? One often wonders, in fact, what possibilities would exist if atoms from the entire periodic table were included as potential macromolecular building blocks. A partial answer to this question is found in *Metal-Containing Polymeric Materials*. This book provides examples of polymers containing iron, cobalt, vanadium, nickel, chromium, and many of the other transition metals. The focus is primarily on polymers which contain metals atoms as an integral part of the polymer backbone, as opposed to complexes formed by incorporation of metal ions or metal particles in a polymeric host.

The book is the outgrowth of a symposium organized by the editors at the American Chemical Society Meeting in August, 1994. The 37 chapters of the overall volume represent contributions from different symposium participants. As one would expect from an edited volume of this type, a wide variety of topics are covered with considerable variations in style between the chapters. Nevertheless, the editors have nicely organized the volume into a sensible grouping of different contributions. The chapters are generally well-written, and include appropriate references so that readers can easily fill in the gaps in their own understanding. Many of the chapters focus on the synthesis of new materials. As an example, one chapter focuses on the synthesis and polymerization of monomers containing clusters of three metal atoms. Other chapters concentrate on the catalytic, electrical, magnetic optical, or ion-exchange properties of metal-containing polymers. A particularly interesting section on biological systems includes an extensive review of transition metal-containing biopolymers. Another section covers recent advances in the synthesis and properties of silicon-containing polymers, and an introductory chapter provides a very useful overview of the general field of metal-containing polymers. Overall, the book provides an excellent snapshot of the current state of this field, and can be digested by anyone with some previous exposure to polymer chemistry. The text is most appropriate for established polymer scientists who are interested in keeping up-to-date with this field, or who would like to learn more about it. Readers in these categories will find this volume to be a very useful and readable reference work.

Reviewer: *Kenneth R. Shull is an assistant professor in the Materials Science and Engineering Department at Northwestern University. His research interests center on polymer interfaces, with a current emphasis on polymer adhesion. His interest in metal-containing polymers arises from work he has done on the properties of metal particle dispersions in polymeric matrices.*

Solid State Electrochemistry

Peter G. Bruce
(Cambridge University Press, New York, 1997)
xvi + 344 pages
$64.95 Cloth, ISBN 0-521-40007-4
$39.95 Paper, ISBN 0-521-59949-0

Solid State Electrochemistry, edited by P.G. Bruce, has been published in the series *Chemistry of Solid State Materials* of Cambridge University Press. It consists of 11 chapters (articles) written by 12 authors. Quoting the editor, the book aims to provide the essential foundation of solid state electrochemistry on a postgraduate level. Beyond the first three chapters, which are basically introductory in the sense that they describe solid electrolytes and their relevant properties, electrolyte materials design is treated (stressing polymers) in addition to ion transport with special emphasis on glass and polymers.

The electrochemical processes at the electrode/electrolyte interface are dealt with conventionally in two relatively short chapters entitled, "Electrode Performance" and "Interfacial Electrochemistry." The last chapter, which is on applications, gives a bird's eye view on solid state batteries, fuel cells, sensors, and several other devices. The first sentence of the book ensures that "this book describes for the first time in a modern text the fundamental principles on which solid state electrochemistry is based," which obviously is overstating. No doubt, some chapters extensively discuss the electrochemistry of polymers, for example. On the other hand, the electrochemical aspects of metal oxidation or solid state reactions in ionic crystals, which by nature are electrochemical processes, are not considered. Zeolites are not found in the index.

Some helpful chapters give, on somewhat different levels of sophistication, general overviews (e.g., "General Consideration, Major Material" and "Material Design"). Others are useful because, on a postgraduate level, they present the authors' view on and expertise in their research field, which is to some extent reflected in the references (e.g., chapter 5; chapter 6, "Polymer Electrolytes"; chapter 9, "Polymer Electrodes"; and chapter 7, "Insertion Electrodes"). The chapter on glass, which covers only a part of current activities, exemplifies this limitation. Redundancies, mainly from the conceptual point of view, cannot always be avoided in a book written by a dozen authors.

If one likes individual preferences and thorough descriptions by experts, here is an interesting book on solid state electrochemistry, illustrated on a postgraduate level in its most important chapters. If one prefers a conceptually homogeneous, carefully elaborated monograph on solid state electrochemistry, there will be others.

Reviewer: *H. Schmalzried, a professor at the Universität Hannover, Germany, has research interests in the areas of solid state thermodynamics, solid state reactions, and solid state electrochemistry.*

Fragile Objects: Soft Matter, Hard Science, and the Thrill of Discovery

P-G. De Gennes and J. Bandoz, translated by A. Reisinger
(Springer-Verlag, New York, 1996)
205 pages, $24.00
ISBN 0-387-94774-4

This marvelous book is a result of a crusade lecturing across the French-speaking world of high schools in which P-G. de Gennes engaged himself, after he received the Nobel Prize in physics in 1991, due to numerous invitations from students, science clubs, and high schools. In this book he talks in an elegant and most simple way about his science (soft matter), about the work of a scientist, and about the role of education and science in the modern world. Every section finishes with very exciting discussions, probing questions from the young students, and the lecturer's spontaneous responses.

Soft matter (*Matière Fragile* in French)

has neither the rigid structure and crystalline symmetry of a solid nor the uniformity and disorder of a fluid or a gas. Soft materials under the influence of a weak external action result in large response with unusual properties. Soft matter encompasses all forms of materials with which we are confronted in everyday life, such as polymers (car tires, textile fibers), liquid crystals (all types of displays), emulsions (milk, beauty creams), and colloids (all types of paints). The book also addresses the properties of foams, bubbles, and the wetting de-wetting of surfaces. These materials and properties are discussed from an amusing historical point of view as well as a simple but exact scientific perspective as to the fundamentals of their working. Throughout the book is shown how humankind invented useful materials for which the fundamental understanding of their working came much later, sometimes centuries after. It also shows with simple examples how the basic understanding of the behavior of soft matter creates new prospects for new discoveries and/or better, more efficient use of the old materials. The role and the qualities of the inventor/scientist as well as the role of the individual versus teamwork in scientific research are exemplified with elegant paradigms. The just balance between applied and fundamental research as well as the values and merits of an engineer and a scientist are discussed, in relation to their services to a modern continuously changing society, with elegant metaphoric examples. The important role of a scientist as an informer for society is discussed. Last but not least, the role of education in the preparation of future scientists and, above all, educated citizens is discussed with the pros and cons of the French educational system in contrast to others.

This absorbing and beautiful book does not teach us only about soft matter and the job of a scientist but also about ourselves. It is strongly recommended not only to all scientists and students but also to research managers and decision-making politicians.

Reviewer: *Georges Hadziioannou is professor of polymer chemistry and scientific director of the Materials Science Center at the University of Groningen, The Netherlands. His present research interests are functional polymers, semiconducting polymer materials for photonic and electro-optic applications, and surfaces and interfaces of polymer materials with experimental expertise in polymer synthesis, advanced electro-optical characterization methods, surface forces, and scanning probes.*

Rare-Earth Iron Permanent Magnets

J.M.D. Coey, editor
(Oxford University Press, New York, 1996)
542 pages, $135.00
ISBN 0-19-851792-0

When neodymium-iron-boron magnets burst upon the scene in late 1983, the European scientific community appeared to be standing on the sidelines. An organized effort to correct this situation became known as the Concerted European Action on Magnets (CEAM). It resulted in a sustained activity that produced a wealth of experimental data, theoretical insights, new materials, and a fruitful exchange of ideas among scientists worldwide, all documented in the numerous publications that flowed from this effort. The present book can be seen as one of the records of European permanent magnet research in the past decade and a half, but it is much more. It guides the reader through the important aspects of rare-earth iron permanent magnet basics, properties, processing, and applications. The specialist can profitably concentrate on one or two chapters and expect them to discuss their subjects in considerable depth. The contributors are all recognized experts in their field and have written lucid expositions of their subject matter.

True to its title, the book focuses almost exclusively on rare-earth permanent magnets containing iron as their principal component. The scope of the topics is wide, ranging from permanent magnet basics to recent applications. Despite the multiple authorship, the book represents a coherent whole, and there is almost no overlap of content. Where English is not the native language of the authors there is no loss of clarity. The introduction (Chapter 1), written by the editor, endeavors to tie together all aspects of permanent magnets and provides a fitting entry into the chapters that follow. It is preceded by one of the few common-sense expositions on magnetic units known to this reviewer.

When the basics in Chapter 1 are combined with the sections on intrinsic magnetic properties (Chapter 2) and coercivity (Chapter 5), one must conclude that nearly half of the monograph is dedicated to the theoretical and experimental fundamentals of the subject. The treatment is not in any sense light or simplistic. A novice to the field will do well to come equipped with a solid grounding in physics, as well as considerable patience. To readers already familiar with the physics and materials science of rare-earth permanent magnets, Chapters 8 through 11 dealing with applications (static fields, magnetomechanical applications, motors, actuators) should be well worth their attention because design parameters have changed considerably with the increased magnetic stiffness of the new materials. Coincidentally, readers will learn that read/write heads in computer disk drives represent the largest application for Nd-Fe-B magnets at the present time. Nd-Fe-B magnets have become the real work horse of the rare-earth permanent magnet business because they provide the highest energy product in industrially available magnets, so they get most of the attention in the book. In a more recent development, the favorable intrinsic properties of the nitride $Sm_2Fe_{17}N_3$ have kindled an intense interest in the modification of the materials by interstitial atoms (Chapter 4). One of the ongoing problems of permanent magnet research is how to extract a useful coercive field from the large crystal anisotropy available in rare-earth transition metal compounds. The most recent insights into this question are discussed in Chapter 5. Chapter 6 on microstructure and magnetic domains is closely related because coercivity is intimately tied to the motion of domain walls through major and minor structural features under the influence of a magnetic field. The phase relations in rare-earth alloys are an important topic because it can help us understand how these alloys behave during solidification and subsequent processing and how this affects magnetic properties. This area is covered in Chapter 3.

The editing of this monograph, which must have been a considerable chore, is professional and has resulted in a pleasing and uniform product. In over 500 pages of printed text the number of typographical errors can never be zero, but here it has been held to a minimum. Over 1,000 references support the research results, and a bibliography with 25 entries form a basis for collateral reading. Most names that have been profiled in permanent magnet research in the past decades are found in the references in one form or other. The book is laid out in an attractive fashion and, incredibly, sewn in signatures which means that it is not likely to come unglued. As an added bonus, the reader can expect it to remain open at a desired spot without having to fight the annoying tendency of the pages to flip over unbidden.

If you are a research worker in this field and want to catch up with developments that are peripheral to your direct interests, or need to know more about applications, or if you are an applications-bound engi-