

BOOK REVIEWS

the true value of this book is as a reference for experimentalists and their research assistants. From a pedagogical standpoint, the sections of this book that discuss the use of statistical methods and tools are not comprehensive and would require the use of supplemental materials if used as a required text in a course. However, as stated earlier, this book provides an excellent laboratory reference for experimentalists already familiar with the basic concepts of uncertainty and statistics.

Inherently Conducting Polymers

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REFERENCE: Aldissi, M., *Inherently Conducting Polymers: Processing, Fabrication, Applications, Limitations*, Noyes Data Corporation, Noyes Publications, Park Ridge, N.J., 1989, \$39.

The feasibility of electrically conducting polymers was explored theoretically in the 1960's but has been the subject of serious research only over the past decade or so. Dr. Aldissi's book reviews the progress of this research and describes the current state of the art. Various aspects of the subject are covered such as synthesis, properties, and applications, with the author adopting a mainly descriptive style.

After a Foreword and short Introduction defining the scope and objectives of the book there is an extensive section on the Synthesis of Conjugated Polymers. These are basic to polymer conduction, and the variety of techniques available for synthesizing them is wide, probably justifying the amount of space devoted to the topic. Most candidate materials are included, for example, poly(paraphenylene), poly(phenylene sulfide), and polyaniline. However, polyacetylene $[(CH)_x]$ is given prominence, being the first extensively characterized organic covalent polymer; it is also used as the benchmark reference throughout the book.

Methods of synthesis are followed by a short section on the Electronic Structure of Conjugated Polymers in which Dr. Aldissi describes the need for a network of overlapping intra- or inter-molecular orbitals to create significant electron or hole mobility, thus providing the basis for conduction. He goes on to say that in practice electron mobility is minimal in most organic polymers and therefore must be stimulated by further processing, using a technique known as doping. This involves the oxidation or reduction of the polymer by electron acceptors or donors to produce either *p*-type or *n*-type conductors respectively. The various routes for producing both types are briefly described, together with a short, necessarily speculative, discussion on the doped structure; this area is still being researched. The narrative

evolves to explain how conduction characteristics can be tailored to match those of a semi-conductor or a metal by varying the concentration and type of dopant. The Magnetic Properties of the doped polymers are also discussed, with reference to electron spin resonance (ESR) and magnetic susceptibility.

One of the strengths of the book is its impartiality, despite the author's understandable enthusiasm for the subject. It manages to address both the advantages and disadvantages of these new materials without bias. For example, research has shown that potentially the most serious obstacle to the wider application of conducting polymers is their stability. It turns out that the conjugated structure whilst facilitating conduction is also responsible for instability, particularly in the presence of water; this is true for both pristine and doped polymers. The book deals with the various aspects of the problem in terms of stability in air, thermal stability, and the influence of structure on stability. Progress in the development of stabilizing techniques such as ion implantation, co-polymerization, and the use of crown ethers is also discussed. I feel this section is of particular value, since it puts the current status of these materials into sharp perspective.

Although undesirable, instability in the presence of water can be put to advantage in the construction of a polymer fuel cell. This is only one of several potential applications identified and described by Dr. Aldissi. Others include photoelectrochemical solar cells, electromagnetic shielding, and electronic circuit boards. However, I suspect that in the authors view the most promising area for development is rechargeable polymer battery technology, since several pages and an Appendix are devoted to it. The efficiencies and technical feasibility of a number of different battery systems are reviewed including lithium-reduced polyacetylene, a leading contender. On a cautionary note the change in potential during charging or discharging is highlighted as the main problem with polymer batteries at present.

In general, I found the text well written, clear, and concise. Although the intended audience is not declared, I feel the most appreciative is likely to be the materials scientist looking for a good basic introduction to the subject. Most factual details are supported by one or more references and therefore can be followed up in greater depth if required. I have to admit that I found the format of the book rather unusual in that it is effectively a research report in a hardback cover, bearing witness to its pedigree. Unfortunately, the photo, print, and paper quality are rather poor, all of which belie the quality of the content. In their defence the publishers do say that a few corners have been cut to expedite publication and keep down the price, but I am not sure the trade-off was worthwhile. However, this is a matter of personal preference and the reader should not be put off by these matters from what is a very useful contribution to the knowledge base.