### Practical Aspects of Finite Element Modeling of Polymer Processing

*Vahid Nassehi*
*(John Wiley & Sons, West Sussex, 2002)*
*273 pages, $135.00*
*ISBN 0-471-490-42-3*

This is a nice, concise book of use to beginners and practitioners wanting to learn how to apply the finite element method to *some* problems in polymer processing. Virtually all the topics and considerations of the finite element method are mentioned; some of them are described in detail. Solutions are given for several polymer-processing applications. The source code for a finite element program is included, but it only applies to power-law fluids in two dimensions, in steady, creeping motion. However, with the differential equations in the book, the element equations in the book, and the program, the beginner can immediately apply the finite element method to some polymer-processing problems. To extend the program to axisymmetric geometry and to viscoelastic fluids, for example, is not a big stretch because all the differential equations and element equations are given in the book. Thus, the book strikes a good balance between being simple enough to understand and being able to solve real problems. The reader should not expect the program to solve viscoelastic problems or even very many real problems.

Chapter 1 gives a quick trip through constitutive equations, using dyadic notation. Chapter 2 describes finite elements and shows how to set up finite element problems including streamwise upwinding and the Petrov–Galerkin method. Chapter 3 includes almost all of the major ideas involving finite elements and polymers, even if they are not implemented in the computer code provided.

Chapter 4 writes down the working equations for Cartesian, polar, and axisymmetric problems (all two-dimensional), and for continuous and discrete penalty methods for pressure. The time-dependent scheme presented is a specialized technique, but the important work of Gresho, Lee, and Sani at Lawrence Livermore National Laboratory should have been given more prominence.

Chapter 5 gives results of several polymer-processing examples done by the author. They include applying the volume of fluid (VOF) method to a single-blade mixer, applying the Arbitrary Lagrange–Euler method to a twin-blade mixer, Couette flow of rubber analyzed with a generalized Newtonian fluid and VOF or with a Maxwell viscoelastic fluid with a Lagrangian method. These results show that the generalized Newtonian fluid does not give the proper normal stresses that the viscoelastic fluid shows, and it would have been nice to have seen the Criminale, Ericksen, and Filbey (CEF) results as well. The Phan-Thien/ Tanner viscoelastic model is applied in a time-dependent problem for a segment of a screw, and a rubber mixer with slip is modeled. The last two problems are a cone and plate viscometer (for a Maxwell fluid) and a thin-layer extrusion.

This book will be of interest to someone wanting to write computer codes, and it is clearly presented for that use. Someone only interested in the general idea can read parts of it and learn what assumptions they may have made inadvertently when using a commercial code. The book does not have enough actual processing situations for it to be a good advertisement of the value of modeling. It is a nice book for its intended purpose.

***Reviewer:*** *Bruce Finlayson is the Rehnberg Professor of Chemical Engineering at the University of Washington in Seattle. His expertise is mathematical modeling, which he has applied to chemical reactors, polymer flow, ferrofluids, fluid mechanics, and heat transfer.*

### Perovskites: Modern and Ancient

*Roger H. Mitchell*
*(Almaz Press, Thunder Bay, Ontario, 2002)*
*vii + 318 pages*
*ISBN 0-9689411-0-9*

Materials science links art, engineering, and science. Nature provides opportunities through the enormous variety of properties of even a restricted range of related materials. The art is to achieve the properties and reproduciblity desired, even from complex or nonequilibrium systems. One might need a mix of fact and art to find microstructures which give the right control of dislocation structures. Or one might need a parallel mix of fact and insight to achieve crystal engineering, in which one exploits the wide range of properties available even in a single range of structures.

The perovskites offer an incredible range of properties, aided by the flexibility of their structure and by their readiness to accept substitutional anions or cations. There are superconductors and ferroelectrics; there are bronzes and dielectrics; there are examples of long-range order of shear planes; there can be octahedron rotation and there may be striking Jahn-Teller effects; there can be a choice between stoichiometric and nonstoichiometric systems. Underlying these properties are certain structural themes. It is these structures, rather than functions, which are the central theme of this excellent book. Its aim is expressed modestly as an introduction to the structural and compositional variation found in perovskite group and related compounds. This it achieves very well, aided by first-rate color figures and a clear layout of the pages. The first eight chapters are organized into specific classes of perovskites, from ideal structures through distorted ones, stoichiometric and nonstoichiometric forms, and hexagonal and layered variants. Each of these chapters is systematically structured, with discussions of simple compounds and of solid solutions. There are helpful data tables, together with many figures, which have clearly been devised with thought. The penultimate chapter addresses high-pressure perovskites, and provides a neat link to the final chapter on naturally occurring perovskite minerals. The minerals discussed include the obvious ones, even those associated with the Earth's interior. A bonus is the welcome discussion of perovskites from diamond inclusions and meteorites. It is a pity that there is no discussion of the substantial work worldwide on the atomistic modeling of perovskites, nor of nonstructural properties, but one can understand the author wishing to keep his volume clearly focused and of convenient length.

There is no subject index. Instead, the author draws attention to the extensive contents list. Up to a point, this is a respectable substitute. But the reader seeking information defined by function (which perovskites have large dielectric constants?) or by phenomenon (which perovskites are Jahn-Teller systems?) will struggle. The two comprehensive indexes of compounds help separate inorganics from organic–inorganic perovskites. The extensive set of references, including titles, passed successfully my spot checks for completeness. In all, this volume more than achieves its aims as a summary of the widely scattered literature on these remarkable systems.

***Reviewer:*** *Marshall Stoneham is Massey Professor of Physics and Director of the Centre for Materials Research, University College London. His wide-ranging interests in materials stem from his years with the Atomic Energy Authority, Harwell, where he was the Chief Scientist of AEA Technology.*

### Intermetallic Compounds: Principle and Practice; *Volume 3*: Progress

*J.H. Westbrook, R.L. Fleischer, Editors*
*(John Wiley & Sons, Chichester, 2002)*
*xlvi + 1036 pages, $485.00*
*ISBN 0-471-49315-5*

*In my offer to continue reviewing the publications within this series on* Intermetallics Compounds *for* MRS Bulletin, *I decided that*



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*my recent review published in* Intermetallics *serves best and is reprinted here.*

The first two volumes of Westbrook's and Fleischer's magisterial work appeared seven years ago. Though some pessimists in our community fear that research on intermetallics is gradually decaying, this new volume puts such fears to flight. As the preface informs us, 27 chapters cover new topics, not treated in the earlier volumes; eight further chapters represent earlier topics "reprised" "because of the intense current activity and great importance of their topic matter." Yet a further seven chapters deal with matter treated before (mechanical properties) but "now totally new approaches were undertaken." For good measure, in the front of the book there is a feature entitled "Some Intermetallic Families Defined" by Westbrook. Westbrook also contributes a chapter on "Intermetallics on the Internet," while Fleischer contributes two chapters, one on "Solution and Defect Hardening" and the other, unexpectedly and fascinatingly, on ion tracks in intermetallics (this is unexpected because intermetallics are electrically conducting).

I pick out here just a few of the new chapters because of their special interest to me or because they are superbly written (or both!). Ira Wolff, formerly of Mintek in South Africa, writes compellingly and at considerable length on "Precious-Metal Compounds," including the Ru–Al intermetallics first drawn to public attention by Fleischer a few years ago. Chapters on amalgams (barely mentioning teeth!) and on beryllides are both illuminating. Didier de Fontaine writes in his usual forceful manner on "Bonding and Stability." I love some words attributed here to Simon Moss: "Electronic structure specialists devote all their considerable talents to calculating internal energies, but regard configurational entropy as a piece of cake, whereas statistical mechanics types look upon calculations on configurational entropy as worthy of a Nobel Prize, but dismiss internal energy as another piece of cake."

Two chapters dealing with applications (1) for high-temperature service and (2) for general use are admirably detailed and comprehensive. A particularly thorough and informative chapter, by Ricardo Schwarz of Los Alamos, covers "bulk amorphous alloys." In this new field, for some reason, the first major innovators (at Caltech and in Sendai) wrote reviews largely about their own work; so here, Schwarz does the same for recent Los Alamos work.

Editorial attention throughout is of the highest standard. The work is peppered with lively historical quotes, many of which positively beg to be lifted for after-dinner speeches. The subject index is extremely comprehensive, and the name index goes out of its way to include authors *after* the first-named one in the myriad references of the chapters; this is a most unusual piece of care.

Once again, as in my review of the first two volumes, I can only urge readers to be sure to acquire this book.

***Reviewer:*** *Robert W. Cahn is attached to Cambridge University. His principal field of metallurgical expertise is intermetallics. He is a member of the editorial board and the book review board of* MRS Bulletin. *This review is reprinted with permission from Elsevier, from* Intermetallics ***10*** *(2002) p. 1033.*



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