BOOK REVIEWS

I. FOUNDATIONS & BASIC METHODS

5R1. Fields, Flows and Waves: An Introduction to Continuum Models. - DF Parker *(School of Math, Univ of Edinburgh, James Clerk Bldg, Kings bldg, Mayfield Road, Edinburgh, EH9 3JZ, United Kingdom).* Springer-Verlag London Ltd, Surrey, UK. 2003. 270 pp. Softcover. ISBN 1-85233-708-7. $34.95.

Reviewed by E DeSantiago (Dept of Civil and Architec Eng, Illinois Inst of Tech, 3201 S Dearborn St, Rm 213, Chicago IL 60616-3793).

This book is intended primarily as a textbook for second-year undergraduate students in mathematics, mathematical physics, and engineering. The book is designed as a first introduction to the use of mathematical techniques, within continuum theories. It is presumed that the readers have some knowledge of several variable calculus and partial derivatives. The author presents many physical problems to motivate the discussion of the conservation and balance laws derived in the text; however, the emphasis of the book is on the solution to the resulting ordinary and partial differential equations. The physical and practical aspects are used to aid in the formulation of the models and in interpreting the mathematical predictions. To this extent many simple examples that allow closed form solutions are included in the text, which help provide insight into the mathematical solutions presented. Each chapter also includes student exercises with solutions given in the end of the book. A sizeable number of figures are also included that illustrate details of the mathematical solutions.

Chapter 1 begins with a general discussion of conservation and balance laws along with their application to steady state heat flow. Chapter 2 introduces unsteady heat flow and Chapter 3 presents the concepts of fields and potentials with applications in electrostatics. Solutions to Laplace's Equation and Poisson's Equation are presented in Chapter 4. Chapter 5 introduces wave theory in the context of elastic strings. Chapters 6 and 7 give a basic introduction into fluid flow and elasticity, respectively, and provide further context for the mathematical formulations that were derived in previous chapters. Chapter 8 gives a more extensive treatment of plane waves. Wave refraction and reflection and guided waves with applications in acoustics and elasticity are also considered. Chapter 9 extends the topics of Chapter 8 to electromagnetic waves. Finally, the text ends with a presentation of how the previously developed mathematical techniques can be applied to describe the growth and spread of biological organisms.

It is clear from the presentation of the material that the author's aim is to employ examples from physical phenomena to motivate the derivation of mathematical formulations and to gain insight into the resulting solutions. Several topics in engineering and physics are presented; however, the discussion of these topics is too brief for students to gain a deep understanding of the material. As such, *Field, Flows, and Waves: An Introduction to Continuum Models* is recommended to students in mathematics and mathematical physics that require only a quick introduction to the several physical topics covered in the text and would prefer to concentrate on the mathematical techniques required to solve such problems.

5R2. The Finite Element Analysis of Shells: Fundamentals. Computational Fluid and Solid Mechanics. - D Chapelle *(INRIA-Rocquencourt, Le Chesnay, France)* and K-J Bath *(MIT, Cambridge MA).* Springer-Verlag, Berlin. 2003. 330 pp. ISBN 3-540-41339-1. $79.95.

Reviewed by C Meyer (Dept of Civil Eng, Columbia Univ, 500 W 120th St, MC 4709, New York NY 10027-6699).

The modern theory of shells, which dates back to Love, more than one hundred years ago, has ever since been a major topic for applied mathematicians and engineers who don't mind solving eighth-order partial differential equations. The introduction of the finite element method in the 1960s seemed to eliminate this need for mathematical astuteness, as practitioners could get the impression that a standard finite element software system would provide correct answers to just about any practical problem, without the need for a fundamental understanding of shell behavior on the user's part.

Nothing could be further from the truth. Each ''shell element'' in a commercially available software system is based on one particular shell theory, and it so happens that different shell theories tend to give different results for the same problem and exhibit widely varying convergence characteristics with mesh refinement. Each shell theory is characterized by its specific modeling assumptions of the kinematic constraints ''through the thickness'' of the shell. This applied primarily for thin-shell theories, because for thick shells, a discretization with solid elements will typically eliminate most potential problems. The primary service that this book by Chapelle and Bathe renders to the profession is that it uses a rigorous mathematical approach to organize these various theories. It assumes that the reader is intimately familiar with tensor notation and the mathematical theory of shells. Readers without such background are unlikely to obtain an understanding of thin shell theory from this book.

After a very short introduction, Chapter 2 introduces geometric preliminaries of vectors and tensors in three-dimensional curvilinear coordinates, which are then used to define the shell geometry. Chapter 3 presents the elements of functional and numerical analysis, that is, Sobolev spaces and their associated norms as well as variational formulations and finite element approximations. With Chapter 4, the book starts getting interesting. It is here where the various kinematic shell models are analyzed with mathematical rigor. Likewise, the presentation of asymptotic behaviors of different shell models, subject of Chapter 5, contains intriguing results of practical significance. Also, the derivation of displacement-based shell finite elements in Chapter 6 proves very elegantly that the popular facet-shell, ie, flat; elements do not satisfy the mathematical criteria for convergence, whereas more efficient displacement-based elements based on general shell theory are available. Chapter 7 presents an in-depth analysis of the influence of the shell thickness on the various theories, and Chapter 8 derives the formulation of effective general shell elements.

Up to this point, the book is limited to small deformations and linear elastic material behavior, characterized by two material constants, Young's modulus and Poisson's ratio. This is a serious limitation. Although the authors claim, in Chapter 9 on the nonlinear analysis of shells, that almost their entire theory is applicable to the nonlinear domain as well, this reviewer is not convinced. Many problems in engineering practice are nonlinear. For metal shells, buckling behavior often controls the design. For concrete thin-shell structures, nonlinear constitutive relations and creep behavior can play significant roles. The theory presented in this book may form a solid foundation, but taking the significant step to nonlinear applications requires more than the few cursory, though valid comments advanced in the very short final chapter.

As already mentioned, the target audience for *The Finite Element of Analysis of Shells-Fundamentals* is the mathematically astute, relatively small group of experts who may be called upon for the development of better software codes, ie, better finite element formulations. The vast majority of practitioners are users of such software and not expected to be experts in mathematical shell theory. It would have been useful to provide them with some guidelines on how to evaluate the relative accuracy and convergence characteristics of different finite element formulations. But this was obviously beyond the purpose and scope of this fine and compact monograph on mathematical shell theory.

5R3. Scaled Boundary Finite Element Method. - JP Wolf *(Swiss Fed Inst of Tech, Lausanne, Switzerland).* Wiley, W Sussex, UK. 2003. 361 pp. ISBN 0-471-48682-5. $130.00.

Reviewed by Long-Yuan Li (Dept of Civil Eng, Aston Univ, Aston Triangle, Birmingham, B4 7ET, UK).

This book describes a fundamental solution-less boundary element method, based on finite elements. The method combines the advantages of both the finite and boundary element methods as the finite element discretization in the method is restricted to the circumferential direction while in the radial direction it uses a scaling procedure to obtain an analytical solution. The method can be used to analyze any bounded and unbounded media governed by linear elliptic, parabolic, and hyperbolic partial differential equations. The book is based on the research and development performed recently by the author and his colleagues. It is a unique research book that presents the development of new numerical procedures that can overcome some difficulties that appear when using the finite or boundary element method.

The book contains 26 chapters, 4 appendices, high quality figures, and a good subject index. References are provided in the alpha beta order, which are listed at the end of the chapters.

The first two chapters provide a brief introduction of numerical procedures and features of the finite element method, boundary element method, and scaled boundary finite element method. More details of the concepts of the scaled boundary finite element method and its applications in model problems and two- and three-dimensional elastodynamic, static's and diffusion problems are presented in Part I and II.

Part I addresses the model problem, which contains 12 chapters (Chapters 3-14). Chapter 3 addresses the concepts of scaled boundary transformation of geometry and similarity. Chapter 4 gives the definition of a model problem. Two derivations of scaled boundary finite element equations are presented. In Chapter 5 the weighted-residual technique is used, and the other in Chapter 6 uses the similarity and finite element assemblage. Chapter 7 discusses the analytical solution of the scalar scaled boundary finite element equations. Chapters 8-12 discuss the solution procedures of the scaled boundary finite element equations in displacement and in dynamic stiffness for bounded and unbounded media. In Chapter 13, implementation issues are discussed, which also apply to the general matrix equations. Chapter 14 gives the conclusions related to the model problem.

At the end of Part I, four short appendices are provided, leading to deeper insight into certain aspects of the model problem, and providing a link to the generalization of two- and three-dimensional static's, elastodynamics and diffusion in Part II. Appendix A deals with solid modeling, Appendix B discusses the analysis in the frequency domain, Appendix C establishes the equations of motion of a dynamic unbounded medium-structure interaction problem using the properties calculated in the Model Problem, and Appendix D describes the early historical development leading up to the scaled boundary finite element method.

Part II has 12 chapters (Chapters 15 to 26), which develops all aspects of the current state of the art of the scaled boundary finite element method. Following the derivation of the fundamental equations based on the scaled boundary transformation (described in Chapter 15), the solution procedures for static's and dynamics in the frequency and time domains, both numerically and analytically, for bounded and unbounded media are developed in Chapters 16-22, respectively. Two- and three-dimensional examples in elastodynamics and diffusion for bounded and unbounded media are discussed in Chapters 23 and 24. Based on the stress recovery technique error estimation and adaptivity are discussed in Chapter 25. Chapter 26 contains concluding remarks and addresses restrictive properties of the novel method and suggestions for future research.

In summary, *Scaled Boundary Finite Element Method*, is a self-contained, well-presented advanced textbook. It is suitable for research students and for the personal bookshelves of research investigators working in the field of computational engineering sciences. It can also be a useful reference in libraries.

IV. MECHANICS OF SOLIDS

5R4. Mechanics of Composite Structures. - LP Kollar and GS Springer. Cambridge UP, Cambridge, UK. 2003. 480 pp. ISBN 0-521-80165-6. $95.00.

Reviewed by M-A Erki (Dept of Civil Eng, Royal Military Col of Canada, PO Box 17000 Station Forces, Kingston ON, K7K 7B4, Canada).

This comprehensive book presents traditional topics of structural mechanics that target the topics of interest for designers of aerospace, land, and marine structures, namely plates, beams, and shells, including where appropriate the analyses for their buckling, vibrations, deformations, and displacements. While the topics are familiar to designers using isotropic materials, in this book they are presented for anisotropic composite materials of all types, which are long-fiber composites, short-fiber composites, particulate composites, unidirectional lamina, biaxial weave woven fabric, and triaxial weave woven fabric. Chapter 1 illustrates these materials. It describes the structure of laminate composites and how the individual plies contribute to the laminate behavior. The chapter also defines the various levels of analysis for a structure made of a laminated composite, from the micro (analysis of the matrix and fiber) to macro (analysis of the composite), ending with structural analysis of components, herein plates, beams, and shells.

The foundation for all subsequent derivations and analyses in the book are given in Chapter 2. It presents the generalized 3D relationships between displacements and strains and between strains and stresses, via equilibrium equations. The stress-strain relationship is developed first for general anisotropic material, followed by the simplifications that can be made for monoclinic material, orthotropic material, transversely isotropic material, and isotropic material. The differences in analytical approaches for plane strain and plane stress analyses are carefully explained using the specific examples for all these materials for the conditions of free end and built-in ends. The effect of temperature and moisture content on strains and stresses is discussed for both the plane strain and plane stress conditions.

A section on boundary conditions and how these are applied to obtain solutions to the equilibrium, stress-strain, and strain displacement equations is given. Continuity conditions between laminated layers that are assumed perfectly bonded are described. Stress and strain transformations using direction cosines and transformation of the stiffness and compliance matrices are discussed for the plane-strain and plane-stress conditions. Finally the strain energy equations are derived, and the Ritz Method is summarized as a solution method for these. The chapter ends with a comprehensive summary of the chapter contents and a numerical example.

Chapter 3 discusses the analysis of laminated composites and the contribution of the behavior of individual plies to the overall behavior of the laminate. Stiffness matrices for thin laminates, an example of symmetrical laminate, balanced laminate and orthotropic laminate, isotropic laminate, and quasi-isotropic laminate are illustrated with numerical examples. The next five chapters present the analyses for the basic structural members composed of composite materials, namely thin plates, sandwich plates, solid and thin-walled beams without and with shear deformations, and shells, all with numerical examples as appropriate. Unique considerations for the finite element analysis of composite materials and composite material structures are described in Chapter 9. Chapter 10 discusses failure criteria for the basic types of composite materials, and Chapter 11 summarizes composite material micromechanics. Three valuable appendices give supplementary material of value to the designer. They are the cross-sectional properties of thin-walled composite beams; the buckling loads and natural frequencies of orthotropic beams with shear deformations; and typical composite material properties.

Owing to the clarity and breadth of its content, *Mechanics of Composite Structures* makes a valuable contribution to the field of analysis and design using composite materials. It is well illustrated throughout. Of note, the examples given throughout are truly excellent, because they are both relevant to the development of the concepts presented and practical for designers. The authors have made a special effort to make the book self-contained so that it can be equally suitable as a text for self-study, senior undergraduate, or for a graduate course.

V. MECHANICS OF FLUIDS

5R5. Level Set Methods and Dynamic Implicit Surfaces. Applied Mathematical Sciences, Volume 153. - S Osher *(Dept of Math, UCLA)* and R Fedkiw *(Dept of Comput Sci, Stanford).* Springer-Verlag, New York. 2003. 273 pp. ISBN 0-387-95482-1. $79.95.

Reviewed by K Piechor (Inst of Fund Tech Res, Polish Acad of Sci, ul Swietokrzyska 21, Warsaw, 00-049, Poland).

Many problems of applied sciences can be reduced to determination of "moving fronts" described implicitly by an equation of the type $\Phi(t,\mathbf{x})=\text{constant}$, where t is the time, and $\mathbf{x}$ is the position of the front. The reviewed book is a sort of "extended" introduction to the core or spirit of these methods and, mostly, to numeric techniques related to them.

The contents of the book can be divided into two parts: Part I comprises Chapters I and II entitled Implicit Functions and Level Set Methods, respectively, and Part II comprising the rest of the book where numerous and diverse applications of the methods to image processing and computational physics are given. Chapter I presents a very elementary mathematical background of the theory of implicit functions. In Chapter II the most important mathematical ideas and numerical techniques of their implementation are presented. They include, among others, Hamilton–Jacobi equations and their numerical treatment, motion in the normal direction, construction of the signed distance function etc.

Some applications, with suitable adaptations, of the level set methods begin in Chapter III. Chapter III itself is devoted to image processing and computer vision problems. The contents of this chapter comprise image restoration, active contour methods, and a sort of multidimensional interpolation known as the reconstruction of surfaces from unorganised data points. The authors focused their attention on mathematical modeling of these problems rather than on the numerical procedures. These are merely mentioned, but numerous graphs and pictures illustrating the power and efficiency of the used methods are given (some of them in full color).

Chapter IV, *Computational Physics*, is the most interesting from the fluid-dynamicist's point of view. It covers hyperbolic conservation laws and compressible flows, two-phase compressible flow, shock waves and also detonation and deflagration waves, solid-fluid coupling and many other topics. Every section begins with the presentation of the mathematical model, its specific mathematical features, an explanation on how to apply the level set methods to such a problem, and a thorough discussion of used numeric procedures, paying much attention to their advantages and disadvantages. For example, the peculiarity of solid-fluid coupling consists in different ways of mathematical description of the two media: for solids the Lagrangian description is more convenient, whereas for fluids the Eulerian coordinates are used. How to find a common and an efficient numerical procedure for treating the solid-fluid interface? The answer to this and similar questions according to the modern state of art can be found in the reviewed book. Another application of the method discussed in the book, concerns problems, which usually fly away from the eyes of the fluid mechanics researchers. These problems relate to simulation of flows for computer graphics.

In summary, *Level Set Methods and Dynamic Implicit Surfaces*, is something between a textbook and a book of reference. Even a beginner in numerics can read it, since every chapter and section starts from basic explanations and definitions, followed by a presentation of the numerical procedures, which are accompanied by precious remarks and comments of people with experience. On the other hand, none of the procedures are set with all details and the necessary rigour. The reader is referred to the original papers, so in this sense it can serve as a valuable book of references. In all aspects, this book is worth being in the library of every student or researcher working in applied mathematics, physics or engineering, but it needs a rather good mathematical preparation.

5R6. Theory and Applications of Viscous Fluid Flows. - RK Zeytounian *(12 Rue Saint-Fiacre, Paris, 75002, France).* Springer-Verlag, Berlin. 2004. 488 pp. ISBN 3-540-44013-5. $109.00.

Reviewed by MF Platzer (Dept of Aeronaut and Astronaut, Naval Postgraduate Sch, Code AA/PL, Monterey CA 93943-5000).

Starting with the derivation of the Navier-Stokes equations for viscous heat-conducting fluids the author proceeds to discuss various forms of these equations, including the special cases of compressible isentropic viscous flow of polytropic gases and viscous incompressible fluid flow. He then discusses the Orr-Sommerfeld theory for the plane Poiseuille flow as well as other basic flow cases, such as steady flow through an arbitrary cylinder, annular flow between concentric cylinders, Benard thermal convection flow, Benard-Marangoni flow induced by tangential gradients of variable surface tension, flow due to a rotating disc, and Rayleigh flow caused by an impulsively started flat plate.

The next three chapters are devoted to the very large and very low Reynolds number limits and to the low Mach number incompressible limit. In the chapter on very large Reynolds number flow the author discusses the application of the method of matched asymptotic expansions to the two-dimensional steady flat-plate flow problem and delineates the relationship of the unsteady Navier-Stokes equations to the inviscid Euler, the Prandtl boundary layer, the one-dimensional gas dynamics and the Rayleigh compressible flow equations. He also discusses the triple deck concept, laminar flow separation on a circular cylinder, and the three-dimensional boundary layer equations.

In the chapter on very low Reynolds numbers, the unsteady-state matched Stokes-Oseen solution for the flow past a sphere and the flow over an impulsively started circular cylinder are discussed, followed by a consideration of the Stokes and Oseen steady-state compressible flow equations and the asymptotic analysis for small Reynolds number flows on a rotating disc.

In the next chapter on low Mach number incompressible limit, the author discusses subtleties involved in analyzing unsteady weakly compressible flows; flow in a bounded cavity and through large aspect ratio channels. He then provides further examples by analyzing the acoustic streaming effect caused by an oscillating circular cylinder, the incompressible flow past a rotating and translating cylinder, the Ekman and Stewartson layers on rotating cylinders, and the Benard-Marangoni thermo-capillary instability problem due to heating of a horizontal viscous liquid from below. Also presented are some aspects of non-adiabatic viscous atmospheric flows and a few other topics, such as the entrainment of a viscous fluid in a two-dimensional cavity and the laminar boundary layer separation phenomenon near the leading-edge region of an airfoil and on an impulsively started cylinder. In this regard, he emphasizes the need for the simultaneous solution of the boundary layer and inviscid flow equations in order to remove the singularity at the separation point, as implemented in the viscous-inviscid interaction procedures.

The next two chapters are devoted to a discussion of the existence, regularity and uniqueness of solutions for the viscous incompressible and compressible flow equations and the stability theory of fluid motion. In particular, the Guiraud-Zeytounian asymptotic approach to nonlinear hydrodynamic stability is elucidated and applied to the Rayleigh-Benard convection problem, followed by an analysis of the Benard-Marangoni thermo-capillary instability problem and the Couette-Taylor viscous flow between two rotating cylinders.

The final chapter of *Theory and Applications of Viscous Fluid Flows* presents the finite-dimensional dynamical systems approach to turbulence by reviewing the Landau-Hopf, Ruelle-Takens-Newhouse, Feigenbaum and Pomeau-Manneville transition scenarios to turbulence. The book is ended by giving examples of strange attractors occurring in various fluid flows, such as in viscous isobaric wave motions or in the flow of an incompressible but thermally conducting liquid down a vertical plane (the Benard-Marangoni problem for a free-falling vertical film).

It is evident from this brief summary that the author's emphasis is on the mathematical aspects of the viscous flow equations and their various asymptotic limit cases and analytical solution methods. His choice of topics and flow problems is meant to provide young researchers in fluid mechanics, applied mathematics and theoretical physics with an up-to-date presentation of some key problems in the analysis of viscous fluid flows. Although the author intentionally limited himself to a select few topics, teachers of advanced viscous flow courses and researchers in this field will welcome this book for its thorough review of current work and the listing of 1156 relevant papers. In my judgment, it meets the stated objective of bridging the gap between standard undergraduate texts in fluid mechanics and specialized monographs.

VI. HEAT TRANSFER

5R7. Nonequilibrium Nondissipative Thermodynamics: With Application to Low-Pressure Diamond Synthesis. Springer Series in Chemical Physics, Vol 68. - Ji-Tao Wang *(Dept of Microelectronics, Fudan Univ, Shanghai, 200433, China).* Springer-Verlag, Berlin. 2002. 254 pp. ISBN 3-540-42802-X. $89.95.

Reviewed by JD Felske (Dept of Mech and Aero Eng, SUNY at Buffalo, 330 Jarvis Hall, Buffalo NY 14260-4400).

This monograph focuses on the phenomenon of reaction coupling and how, through a non-equilibrium chemical pump effect, a reaction may occur which otherwise would be thermodynamically impossible. In contrast to Prigogine's consideration of such phenomena in dissipative biological systems, the present text treats a nondissipative, inanimate system-low-pressure CVD growth of diamond films.

The first two chapters introduce the relevant concepts from equilibrium and irreversible thermodynamics. In addition, a special thermodynamic category is defined–nonequilibrium, nondissipative–which applies to complex systems (especially open systems) wherein thermodynamic coupling occurs between simultaneous processes such that in a system of two coupled reactions, one reaction can exhibit a *negative* rate of entropy production while the other exhibits an equally large positive rate, thereby resulting in a zero overall rate of entropy production. As the author points out, this concept has met with some resistance in the scientific community.

Chapters 3 and 4 detail the interesting history of various attempts to produce diamond in the laboratory. Both empirical/anectdotal as well as scientific efforts are described. The first scientific efforts, based on the equilibrium phase diagram for carbon, are shown to have necessarily required very high pressures. Low-pressure pyrolysis techniques were subsequently investigated and, like the high-pressure approach, are shown to have met with limited success. As the author points out, however, the essential leap forward was made by the Russian group headed by Deryagin, who discovered the *activated* low-pressure diamond synthesis technique which enabled the production of diamond films at a rate several orders of magnitude faster than by pyrolysis. The theoretical questions regarding the thermodynamics and kinetics of this activated process are shown to have remained an enigma for decades. Several of the models, which were put forth, are discussed, and the shortcomings of each are carefully delineated. Much of the remainder of the text is then dedicated to the author's resolution of the thermodynamic question. Also put forward is the author's (reasonable) hypothesis for the atomic/molecular interactions occurring at the graphite and diamond surfaces.

Chapter 5 details the author's nondissipative reaction coupling model for explaining the phenomenon of activated low-pressure diamond synthesis. This model is shown to be driven by a chemical pump that requires an input of energy. In the process considered (the transformation of graphite to diamond), atomic hydrogen is generated from molecular hydrogen by an input of energy at high temperatures (filament, plasma, microwave, . . .). Consequently, at the lower substrate temperatures, this atomic hydrogen is at *superequilibrium*. Such concentrations of atomic hydrogen are highly reactive with the unsaturated sp^2 bonds of graphite but quite unreactive with the saturated sp^3 bonds of diamond. The overall coupling process is thereby unidirectional: the hydrogen reacts with the graphite surface producing gaseous hydrocarbons (CH_4, C_2H_2, . . .) which are then transported to the diamond surface and aid the growth of various diamond facets (ie C_2H_2 promotes (111) growth; CH_3 promotes (100) growth). Upon deposition, the carbon is associated into the diamond lattice and the hydrogen leaves the diamond surface in molecular form.

Thermodynamically, the interaction of the superequilibrium atomic hydrogen with the graphite is considered to produce an *activated graphite* surface whose free energy becomes greater than the free energy of the diamond surface. Hence, the superequilibrium atomic hydrogen acts as a chemical energy pump, which results in diamond being the favored growth phase. The overall chemical pump reaction is written as a sum of two reactions: $[\mathrm{C(gra)}=\mathrm{C(dia)}]+\chi[\mathrm{H}=0.5\mathrm{H}_2]$, where χ is an experimentally determined "pump parameter" which, if large enough, results in the necessary reduction in free energy to enable the overall reaction to occur.

The concept of a phase diagram for this complex system is then presented. Such diagrams, unlike the usual phase diagrams, represent a *nonequilibrium* system. In the present application, they are also for the special class of *stationary* nonequilibrium states (ie, time invariant). The basis for their calculation is Prigogine's *principle of minimum entropy production* combined with the assumption that the processes is *nondissipative*. This combination requires a zero rate of entropy production for the overall process or, equivalently, a zero rate of free energy dissipation. The details of computing such phase diagrams are then carefully presented. The nonequilibrium aspect arises from there being two temperatures in the system (filament and substrate). Hydrogen atoms are generated from hydrogen molecules under equilibrium conditions at the filament temperature whereas the graphite and diamond surfaces are at the (lower) substrate temperature. The phase predictions (gas, graphite, diamond, "carbon") of these nonequilibrium phase diagrams are demonstrated to be quantitatively consistent with data taken under a wide variety of conditions. Such agreement represents a strong endorsement of the nonequilibrium, nondissipative, and chemical pump model.

In chapters six and seven, nonequilibrium phase diagrams are developed for a number of other systems. In Chapter 6, the binary systems (C-H, C-O) are treated. In Chapter seven, several ternary systems (C-H-O, C-H-F, C-H-Cl) are considered. The eighth chapter presents some details regarding other debates associated with the concept of reaction coupling. It also presents a detailed discussion and correction of the "unified barrier" model. Chapter 9 presents some observations concerning a number of different systems: activated CVD of cBN, the Belousov-Zhabotinsky oscillating chemical reactions, Schroedinger's ''negative entropy,'' and the similarities of reaction coupling between biological and inanimate systems. The author concludes with his overview of ''modern thermodynamics'' for which he defines the following divisions (subdivisions): Nondissipative Thermodynamics (equilibrium; nonequilibrium) and Dissipative Thermodynamics (linear; nonlinear).

I found *Nonequilibrium Nondissipative Thermodynamics: With Applications to Low-Pressure Diamond Synthesis* to be well written (although a bit repetitive). The historical aspects of the successes and failures to produce diamond from carbon were both interesting and enlightening. Also, the author's presentation of his nondissipative, nonequilibrium, and chemical pump model was very clearly and convincingly made. Overall, this book should be of interest not only to those who work in diamond film production but to thermodynamicists and biochemists as well.