AIAA JOURNAL
Vol. 38, No. 8, August 2000

Book Reviews

Mechanics of Composite Materials and Structures

Edited by Carlos A. Mota Soares, Cristóvao M. Mota Soares, and Manuel J. M. Freitas, NATO Science Series E—Vol. 361, Kluwer Academic Publishers, Dordrecht, The Netherlands, 1999, 517 pp., $185.00

This book represents a compilation of lectures delivered at the NATO Advanced Study Institute on the Mechanics of Composite Materials and Structures held in Troia, Portugal, in July 1998. The attending and participating scientists and engineers included over 100 representatives from universities, research institutions, and industry. The 34 papers contributed are included in the book, with a number of authors contributing several papers. As stated in the preface, emphasis was placed on reporting trends associated with the mechanics of composite materials and structures as follows: 1) classical and recent theoretical advances in the theories of laminated beams, plates, shells, micromechanics, textile composites, high-strain-rate testing, and nondestructive evaluation (NDE); 2) topics of increasing interest, including numerical methods, optimization, identification, and damage monitoring; and 3) state-of-the-art modeling of smart composite materials, optimal design with advanced materials, software codes, and industrial applications. Because of the large number of papers in the book, I present a representative review of selected papers from each of the three emphasized areas.

The first selection, "Impact and High Rate Testing of Composites," by Blackman and Williams, presents an overview of the field of impact and high-rate testing of composite materials. It begins with a need statement for impact and high-rate data, including the distinguishing features of an impact vs a high-loading-rate event. The types of impact damage, as well as test methods to characterize impact and high-load-rate events, are reviewed. This includes pendulum impact, falling weight, gas gun, pressure bar, servo-hydraulic device, and high-rate delamination testing. A summary table of tests and strain rates is included. Abbreviated sections dealing with the nature of dynamic effects and schemes to mitigate such effects, as well as the need for standardization of test methodology, are included. As the authors note, page limitations preclude a sufficient treatment of the topic. Two examples include the omission of CAI (compression after impact) and a comprehensive reference list. The second choice, "Optimization of Thin-Walled Structures," by Stein and Barthold, discusses optimization of thin-walled structures. The introduction discusses the basic elements of the structural optimization process: the optimization problem, the mathematical programming algorithm, and the structural analysis. The authors focus on structural optimization of thin-walled structures composed of fiber-reinforced materials where local and global stability and failure are of key importance in controlling the design process. Two important issues of structural optimization are discussed: the development of an efficient theoretical approach to hierarchical design models for implementation with automated CAD optimization approaches and the importance of modeling stability phenomena for development of robust and reliable designs. The third selection, "Prospects of Smart Structures for Future Aircraft," by Dittrick, includes an abbreviated introduction to smart structures, a description of important smart structures concepts, basic considerations in applicability of smart structures, and a statement of smart structural needs and requirements within the aircraft industry. As noted, smart structures represent a combination of structural materials with sensor and actuator functions. For aerospace applications, a number of interesting functions are possible, including change of structural properties, sensing of structural conditions, flow and thermal control, electromagnetic interaction with the environment, and signature control. Two useful tables are included, the first denoting typical functional elements under investigation and the second denoting typical parameters of smart actuator materials. Some of the important potential applications of smart structures include fiber-optic sensors for measuring or monitoring structural damage, shape control of airfoil surfaces, reduction of inspection costs for aircraft sustainability, and extending the allowable range of design parameters. The author notes that the exploitation of smart structures by the aircraft industry will require demonstration and answers to a number of key technology questions, including a more complete description of material laws for smart materials.

Although only 3 papers of the 34 in the book have been briefly addressed, the remaining papers present the same flavor of information. Each is patterned as an extended abstract with abbreviated discussions and a cursory reference list. Overall, the book presents information on a variety of composite topics that should be helpful to the scientist and engineer who need a quick reference to the state of the art on a number of key issues related to composite materials and structures.

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Thermomechanics of Composites Under High Temperatures

Yu. I. Dimitrienko, Kluwer Academic Publishers, Dordrecht, The Netherlands, 1998, 347 pp., $159.00

This book is dedicated to developing and stimulating study associated with the thermomechanical behavior of composites at *high* temperatures. The italics are significant for distinguishing the behavioral response of materials at normal and elevated temperatures by accounting for irreversible physical and chemical transformations that may occur in the matrix and/or reinforcements at high temperatures (>200°C). It is noted that, at such temperatures, thermo-decomposition and ablation is possible, increasing problem complexity and requiring the consideration of several disciplines, including thermal physics, thermal chemistry, and solid mechanics.

The book consists of 12 chapters and an appendix. The first chapter is introductory and examines the principal sources of high-temperature effects on composites, such as aerodynamic heating. The importance of high temperatures in composite physiochemical transformations accompanied by ablation, i.e., loss of mass, is discussed. Chapters 2 and 3 present a general development of the governing equations of ablative composites at high temperatures. Chapters 4 and 5 focus on studies of the behavior of the basic constituents of composites, that is, the matrix and its reinforcements, at high temperatures. Chapter 4 examines the isotropic behavior of ablative matrices at high temperatures, considering the interrelationship between the micro- and macrocharacteristics of the matrix phases. The effect of high temperatures on reinforcing elements used in matrices, including dispersed particles, short fibers, and continuous fibers, is discussed in Chapter 5. Chapters 6 and 7 analyze the behavior of unidirectional and textile composites subjected to high temperatures, and Chapter 8 discusses the behavior of composites reinforced by dispersed particles and subject to high temperatures. The models presented allow for an evolution of the main material characteristics, including strength, modulus, and ablation rate. Chapters 9 and 10 examine the effects of gradient heating on composites, with Chapter 9 focusing on the phenomena and Chapter 10 examining the linear ablation problem. Chapters 11 and 12 examine the subject of thermal stresses in composite structures, with the former examining the general problem formulation and the latter the evaluation of thermal stresses in thin-walled structural shells. The abbreviated appendix discusses key experimental methods for determining composite material properties under high temperatures, including such parameters as density, heat conductivity, gas permeability, elastic modulus and strength, deformations, and linear ablation rate.

This book appears as a first-time exposition of the methodology associated with modeling the thermomechanical behavior of composites considering physiochemical transformations. The book is well organized, with a logical progression of the topical areas presented. A representative reference list is included at the end of the book, with a strong representation of the Russian literature. A summary of the nomenclature as well as subscripts used is included at the beginning of the text. This book will be a welcome addition to the literature for those scientists and engineers faced with the challenge of designing advanced composite materials for use at high temperatures.

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Errata

Pagination Error

[AIAA Journal, 38(7), pp. 1273–1303 (2000)]

IN the July 2000 issue of *AIAA Journal*, the printer inadvertently ran pages 1273–1303 out of order. All of the pages appear, but the reader will have to check the actual page numbers when perusing the papers published in the affected section of the journal. We regret the inconvenience caused by this error.