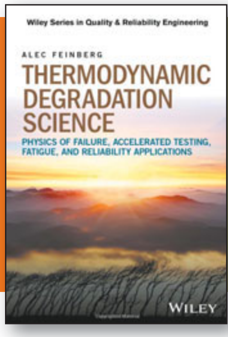


Thermodynamic Degradation Science: Physics of Failure, Accelerated Testing, Fatigue, and Reliability Applications

Alec Feinberg

Wiley, 2016
264 pages, $115.00
ISBN 978-1-119-27622-7

This book uses thermodynamic concepts coupled with physical analogies to address the complex issues associated with material degradation. As part of the Wiley Series in Quality and Reliability Engineering, this text presents a review of thermodynamic principles from the perspective of reliability engineering. The laws of thermodynamics are restated in terms of damage and repair rather than simply as the result of state variables.

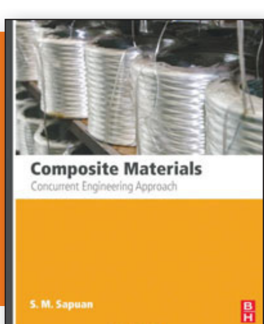
The book begins by introducing equilibrium thermodynamics as a foundation for discussing the behavior of nonequilibrium systems. The second chapter clearly states the nomenclature required to bridge the two, including numerous explicit examples spanning many physical paradigms. Later chapters describe the utility of key concepts and analytical tools in addressing thermodynamic degradation, including work, accelerated testing, corrosion, thermal activation, viscoelastic and fatigue effects, and diffusion. Activation (Arrhenius) and other aging laws are discussed in the context of specific applications as well as predicting failure.

The last chapter and the appended "Special Topics" suggest interesting directions in which the developed methods can be taken, but seem rushed relative to the richness of the early chapters. This may be a limitation of the organization in conjunction with the paucity of work done in this area to date. This is a minor limitation of the enlightening approach used throughout the remainder of the text. The "Special Topics" include reliability statistics, accelerated testing, and the conceptualization of humans as thermodynamic engines, which can wear in predictable ways.

Practical examples from classical physics and biomechanics are abundant. Each chapter concludes with a summary of key concepts and equations. Thermodynamic laws are restated in terms of nonequilibrium processes, and then used to derive common semiempirical and theoretical results from Miner's rule to the diffusion equation. The early chapters include tables that explicitly list variables and equations of interest, which allow the developed methods to be applied to any classical physical system by analogy. Later chapters extend these analogies to nonequilibrium examples, including accelerated aging. The presentation is very accessible and avoids overly complex mathematics in favor of intuitive, descriptive derivations. As one might expect with a book presenting a new perspective, the nomenclature can be somewhat challenging. The author therefore takes pains to clarify the terminology. In some cases, primarily arising in the "Special Topics," attempts to use existing terminology rather than developing an alternative is confusing.

This book is a useful reference for anyone engaging in research or graduate-level instruction in thermodynamics, aging, degradation, and damage. Chapters do not include exercises and examples do not yield numerical results, instead focusing on the conceptual products of this line of reasoning. The tables, figures, and chapter summaries also allow the text to serve as a useful reference for those working in classical thermodynamics.

Reviewer: Matthew A. Reilly *is an assistant professor in the Department of Biomedical Engineering, The Ohio State University, USA.*



Composite Materials: Concurrent Engineering Approach

S.M. Sapuan

Butterworth-Heinemann, 2017
338 pages, $119.00 (e-book $119.00)
ISBN 9780128025079

This book is innovative in that it applies the concepts of concurrent engineering to composite materials. According to Report 338 of the US Institute for Defense Analyses (1988), concurrent engineering is the "systematic approach to the integrated design of products and their related processes including manufacture and support." Composite materials are a current and ever-growing area.

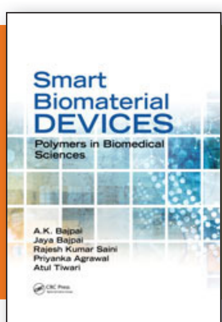
In this book, Sapuan emphasizes the importance of considering the manufacturing aspects in the early stages of product design and development. The book presents details of concurrent engineering for composite development, including the conceptual design of composite materials, materials selection, and design for sustainability. The first chapters describe the background for concurrent engineering, design for sustainability, conceptual design for composites (including several models for design), and materials selection using composites. In sequence, composite materials are defined, and their applications are listed for some industries along with their manufacturing methods. Polymer matrix composites (PMCs) are emphasized, especially natural biodegradable matrices and fibers. One example is poly(lactic acid) reinforced with natural fibers, such as hemp, sisal, or kenaf. The author addresses specific processes for PMCs, such as injection molding, transfer molding, hand lay-up, compression molding, and pultrusion. Nanocomposites are briefly mentioned. The concurrent engineering of composites is presented with some case studies.

The chapters "Conceptual Design in Concurrent Engineering for Composites" and "Materials Selection for Composites: Concurrent Engineering Perspective" are the richest ones, providing undergraduate engineering students an easy and stimulating guide for designing with composite materials. The use of concurrent engineering tools for the development of natural fiber composites is emphasized, and several examples are given, mainly those developed in Malaysia. Also included are highlights for computer-based methods, such as the digital logic method, weighted property method, quality function deployment, and the use of materials databases (Ashby's charts, knowledge-based systems, rule-based systems, and the Exsys Corvid system). The book concludes with design for sustainability, giving the use of natural fibers for composites and the socioeconomic consequences of this approach as an example.

Each chapter presents an up-to-date list of references, several of them from Malaysian institutes or universities. Figures and tables are well-designed and presented, but colored figures are absent and would have been useful.

The book is rich in examples of concurrent engineering application for the development and trends for composite materials. What differentiates this book from others on composites is that examples are provided for the development and design of automotive, aerospace, marine, and aircraft components, most of them using natural fiber composites. This book is recommended for undergraduate students or beginning graduate students. As a professor of composite materials, I think that this book could be used as a complementary reference for undergraduate and graduate courses, such as in composite materials, materials selection, and design and manufacturing disciplines.

Reviewer: Adriano Michael Bernardin *is a professor in the Materials Science and Engineering Graduate Program, University of the Extreme South of Santa Catarina, Brazil.*



Smart Biomaterial Devices: Polymers in Biomedical Sciences

A.K. Bajpai, Jaya Bajpai, Rajesh Kumar Saini, Priyanka Agrawal, and Atul Tiwari

CRC Press, 2016
228 pages, $169.95 (e-book $152.96)
ISBN 9781498706988

The research field of smart biomaterials is highly interdisciplinary. This book summarizes the main types of smart polymeric materials by focusing on medical applications. It is structured into nine short chapters, each containing extensive reference lists.

The special requirements to be met by the scaffold materials used in biomedical devices are revealed: biocompatibility, biodegradability, mechanical properties, scaffold architecture, manufacturing technology, and the proper choice of material. In this context, smart polymeric materials are classified based on their physical form, external stimuli to be responsive, and biomedical applications. Actually, the quality of a "smart" material is conferred by its controlled capacity to respond to light, pH, temperature, mechanical stress, magnetic field, or molecular stimuli.

Most of the chapters, from 2 to 8, are devoted to various biomedical materials and devices, such as drug delivery and tissue-engineering biomaterials, dental and orthopedic implants, and also wound-dressing, ocular, and cardiovascular devices. Each chapter ends with a discussion of current challenges and further perspectives. The final chapter highlights the market scenarios for various biomaterial-based devices, with a particular emphasis on the Indian market.

The schemes and figures benefit the text; however, the text is not presented in an attractive format to engage beginners. In addition, although the cited references are quite exhaustive (totaling more than 1000 books and scientific papers), most are from before 2010; since then, huge advances have been made in all of these smart biomaterials and devices, such as life-sustaining stents, prosthetic heart valves, sophisticated operational tools, imaging technologies, ultra-modern diagnostic kits, and drug delivery systems involving natural bioactive compounds.

This book might be of interest as introductory material for students and early-career researchers embarking on MSc and PhD studies, and for industry and marketing professionals involved in biomedical materials science and engineering. However, I recommend those actively working in the field to look elsewhere for a more thorough and up-to-date book on the subject.

Reviewer: Aurelia Meghea *is an Emeritus Professor at the University Politehnica of Bucharest, Romania.*