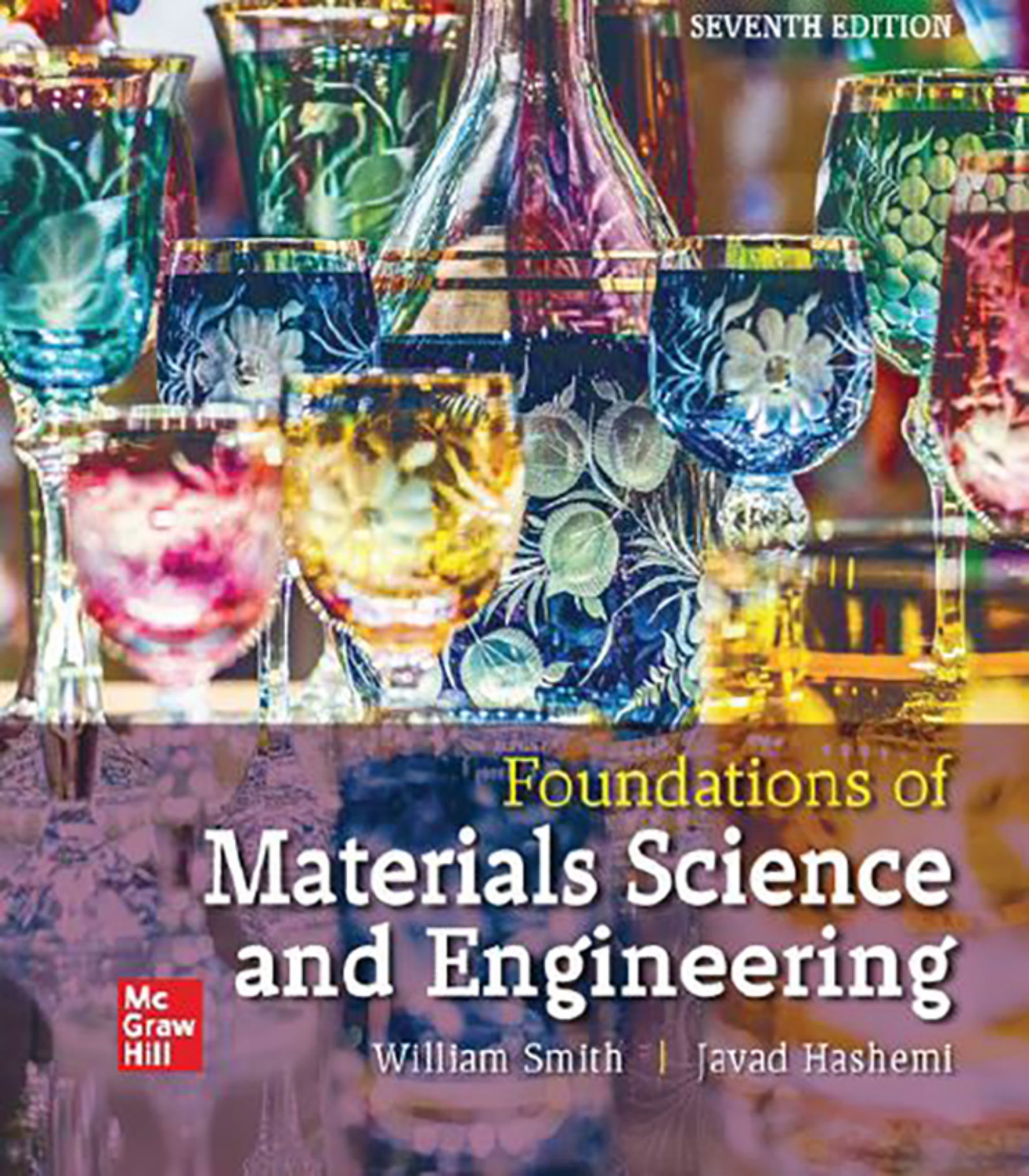
SEVENTH EDITION
Foundations of
Materials Science
and Engineering
Mc
Graw
Hill
William Smith | Javad Hashemi

Foundations of Materials Science and Engineering

Seventh Edition

William F. Smith
Late Professor Emeritus of Engineering of
University of Central Florida

Javad Hashemi, Ph.D.
Professor of Ocean and Mechanical Engineering
Florida Atlantic University

Mc Graw Hill

This book is printed on acid-free paper.

1 2 3 4 5 6 7 8 9 LCR 27 26 25 24 23 22

ISBN 978-1-260-59770-7
MHID 1-260-59770-9

Cover Image: *Shutterstock/Flying Camera*

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The late **William F. Smith** was Professor Emeritus of Engineering in the Mechanical and Aerospace Engineering Department of the University of Central Florida at Orlando, Florida. He was awarded an M.S. degree in metallurgical engineering from Purdue University and a Sc.D. degree in metallurgy from Massachusetts Institute of Technology. Dr. Smith, who was a registered professional engineer in the states of California and Florida, taught undergraduate and graduate materials science and engineering courses and actively wrote textbooks for many years. He was also the author of *Structure and Properties of Engineering Alloys,* Second Edition (McGraw Hill, 1993).

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PREFACE

The subject of materials science and engineering is an essential course to engineers and scientists from all disciplines. With advances in science and technology, development of new engineering fields, and changes in the engineering profession, today's engineer must have a deeper, more diverse, and up-to-date knowledge of materials-related issues. At a minimum, all materials science and engineering students must have the basic knowledge of the structure, properties, processing, and performance of various classes of materials. This is a crucial first step in the materials selection decisions in everyday rudimentary problems. A more scientific understanding of the same topics is necessary for designers of complex systems, forensic (materials failure) analysts, and research and development engineers/scientists.

Accordingly, to prepare materials scientists and engineers of the future, *Foundations of Materials Science and Engineering* is designed to present diverse topics in the field with appropriate breadth and depth. The strength of the book is in its focus on key concepts in science of materials (basic knowledge) followed by application of scientific principles in selection and engineering of materials (applied knowledge). The basic and applied concepts are integrated through concise textual explanations, relevant and stimulating imagery, detailed sample problems, electronic supplements, and homework problems. This textbook is therefore suitable for both an introductory course in materials at the sophomore level and a more advanced (junior/senior level) second course in materials science and engineering. Finally, the seventh edition and its supporting resources are designed to address a variety of student learning styles based on the well-known belief that not all students learn in the same manner and with the same tools.

With every new edition, it is our intent to improve and complement the explanations of the underlying science of materials. As a result, in this new edition, we have made numerous updates described below:

- Chapter 1, a section on the ever important environmental considerations in selection of materials has been added. Life-cycle analysis for materials selection and sustainability (renewable materials and nonrenewable materials) has been introduced. We hope to expand on this topic in future editions.
- Chapter 2, the important concept of energy levels for multi electron atoms has been explained in detail. The concept of effective nuclear charge accounting for electron shielding is clarified and Slater's rule used to determine the energy associated with any electron is introduced.
- Chapter 3, a more detailed explanation of Bravais lattice, unit cells, the extent of symmetry of a unit cells, and motif is presented.
- Chapter 4, the concept of Gibbs free energy is discussed in more detail and the derivation of the critical radius for stable solidification has been updated.
- Chapter 5, the relationship between number of vacancies and Gibbs free energy is explained. The theoretical foundation and development of Fick's second law is described.
- Chapter 6, the concept of resolved shear stress is explained in more detail.

- Chapter 7, theoretical strength, Griffith's theorem, and stress concentration factors are introduced to enhance understanding of brittle fracture of materials. The concept of stress intensity factor is introduced and fracture toughness is explained in more detail.
- Chapter 9, the impact of specific alloying elements on properties of steel is discussed.
- The end-of-chapter problems have been classified according to the learning/ understanding level expected from the student by the instructor. The classification is based on Bloom's Taxonomy and is intended to help students as well as instructors to set goals and standards for learning objectives. The first group in the classification is the Knowledge and Comprehension Problems. These problems will require students to show learning at the most basic level of recall of information and recognition of facts. Most problems ask the students to perform tasks such as define, describe, list, and name. The second group is the Application and Analysis

Problems. In this group, students are required to apply the learned knowledge to the solution of a problem, demonstrate a concept, calculate, and analyze. Finally, the third class of problems is called Synthesis and Evaluation Problems. In this class of problems, the students are required to judge, evaluate, design, develop, estimate, assess, and in general synthesize new understanding based on what they have learned from the chapter. It is worth noting that this classification is not indicative of the level of difficulty, but simply different cognitive levels.

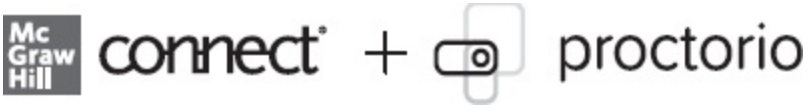
- Over 150 new problems have been developed, mostly in the synthesis and evaluation category. These problems are intended to make the students think in a more in-depth and reflective manner. This is an important objective of the authors to help instructors to train engineers and scientists who operate at a higher cognitive domain.
- The instructors' PowerPoint® lectures have been updated according to the changes made to various chapters. These detailed, yet succinct, PowerPoint lectures are highly interactive and contain technical video clips, tutorials for problem solving, and virtual laboratory experiments. The PowerPoint lectures are designed to address a variety of learning styles including innovative, analytic, common sense, and dynamic learners. Not only is this a great presentation tool for the instructor, it creates interest in the student to learn the subject more effectively. We strongly recommend that the instructors for this course view and test these PowerPoint lecture presentations. This could be especially helpful for new instructors.

Additional resources available through the Instructor Resources are animations; tutorials; and a searchable materials properties database.

DIGITAL LEARNING TOOLS

Proctorio

Remote Proctoring & Browser-Locking Capabilities



Remote proctoring and browser-locking capabilities, hosted by Proctorio within Connect, provide control of the assessment environment by enabling security options and verifying the identity of the student.

Seamlessly integrated within Connect, these services allow instructors to control students' assessment experience by restricting browser activity, recording students' activity, and verifying students are doing their own work.

Instant and detailed reporting gives instructors an at-a-glance view of potential academic integrity concerns, thereby avoiding personal bias and supporting evidence-based claims.

ReadAnywhere

Read or study when it's convenient for you with McGraw Hill's free ReadAnywhere app. Available for iOS or Android smartphones or tablets, ReadAnywhere gives users access to McGraw Hill tools including the eBook and SmartBook 2.0 or Adaptive Learning Assignments in Connect. Take notes, highlight, and complete assignments offline–all of your work will sync when you open the app with WiFi access. Log in with your McGraw Hill Connect username and password to start learning–anytime, anywhere!

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Tegrity in Connect is a tool that makes class time available 24/7 by automatically capturing every lecture. With a simple one-click start-and-stop process, you capture all computer screens and corresponding audio in a format that is easy to search, frame by frame. Students can replay any part of any class with easy-to-use, browser-based viewing on a PC, Mac, iPod, or other mobile device.