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(英文版·原书第4版)

材料科学 与工程基础

Foundations of Materials Science
and Engineering

(美) William F. Smith 著
Javad Hashemi

 机械工业出版社
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引进国外优秀原版教材，在有条件的学校推动开展英语授课或双语教学，自然也引进了先进的教学思想和教学方法，这对提高我国自编教材的水平，加强学生的英语实际应用能力，使我国的高等教育尽快与国际接轨，必将起到积极的推动作用。

为了做好教材的引进工作，机械工业出版社特别成立了由著名专家组成的国外高校优秀教材审定委员会。这些专家对实施双语教学做了深入细致的调查研究，对引进原版教材提出了许多建设性意见，并慎重地对每一本将要引进的原版教材一审再审，精选再精选，确认教材本身的质量水平，以及权威性和先进性，以期所引进的原版教材能适应我国学生的外语水平和学习特点。在引进工作中，审定委员会还结合我国高校教学课程体系的设置和要求，对原版教材的教学思想和方法的先进性、科学性严格把关。同时尽量考虑原版教材的系统性和经济性。

这套教材出版后，我们将根据各高校的双语教学计划，举办原版教材的教师培训，及时地将其推荐给各高校选用。希望高校师生在使用教材后及时反馈意见和建议，使我们更好地为教学改革服务。

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影印前言

材料科学是阐述材料的内部结构、性能和加工成型过程的基础知识；材料工程是应用这些基础知识使材料转化为社会所需的产品。材料科学与工程就是将两者结合起来，它是基础学科（物理、化学、力学、数学）和各种工程学科（机械、动力、能源、化工、航空等）之间的桥梁。

Smith是一位有丰富教学经验的教授。他的著作《Structure and Properties of Engineering Alloys》(1981)已于1984年由国内翻译出版。随后他又写了《Principles of Materials Science and Engineering》(1986)，在国内有影印本。这两本书当时在国内受到了广泛关注，并对专业教学产生了一定影响。本书是作者在上述一书的基础上扩充改写而成。

这本书有两个最显著的特点。该书是材料科学与工程专业学生的第一门入门课，它要让初学者先对专业有一个概貌性的了解，并获得一定的基础知识和材料方面的知识。在过去的专业教学中，“材料科学基础”和“材料学”是分课设置，各按学科自成体系。学生在学习过程中，常感“材料科学基础”抽象难学，不知学有何用，而后续课“材料学”又感到繁琐枯燥，缺少理论依托，因而也未能真正理解消化。本书克服了这一缺憾，将材料科学基础与材料学两者有机地结合起来，它以材料为中心，从培养材料工程师着眼，有选择地选取基础知识内容，将本书化解为四个交叉组成部分：①基础知识；②材料制备方法；③各种材料；④材料的力学、物理和化学性能。这种组合方式优点是显而易见的：结构紧凑，内容精炼，完整实用，学生受益。例如，本书第13章腐蚀，如有了该章的基础，似乎不必另开一门“金属的腐蚀和防护”，有了第14、15、16章的基础知识，似乎也不必另开一门“材料物理性能”来讨论电、磁、光、超导等，而这些知识又和具体材料结合起来，突显出学以致用。值得注意的是，在美国似乎现已趋于这种教学体系。

这本书的另一突出优点，是在每章之后都贯穿有材料选择与设计的专门思考题，这是作者精心设计的，也是他多年教学经验的积累。每个题目都是从工程实际出发，科学地培养学生的研究方法和分析思路，能真正使学生在正确选材的能力上有所提高，也为开发创新材料打下良好的基础。这里我们可略举一些例子。例如，第2章原子结构与结合键有思考题：石墨和金刚石都是由碳原子构成，为什么在性能上有如此大的差异？不锈钢中含有大量铬，为什么铬能防止腐蚀？第3章晶体结构中有习题：给你一未知材料，你能用哪些方法识别它？通常，在高温高应力下工作的燃气轮机叶片，制备成大的单晶，你认为单晶叶片有什么优点？应选取什么材料？（这两个问题虽然学生暂时不能给予全面正确的答案，但对培养同学思考和下一章的深入学习有帮助。）在第4章凝固、晶体缺陷和扩散中有习题：燃气轮机叶片由长的柱状晶组成，试提出实现方向性凝固的方法；从凝固观点解释焊接过程，影响焊接接头的关键因素有哪些？两

种不同金属接触，会产生一种叫柯肯达尔效应，如何解释这一现象？需要指出的是，这几道习题原本是传统教材中的讲课内容，现延伸为本章的课外作业，在启发学生思考，指导学生自学以后，同样获得了上述知识，显然这种学习方法印象更深，兴趣更大。又如第12章复合材料有习题：用纤维可增加陶瓷材料的韧性，但在这种情况下，纤维与基体的结合应不是很强，试解释这个过程何以能韧化陶瓷材料？该题点出了韧化陶瓷材料的技术关键。本书每章的最后都落脚于材料的选择与设计，在培养学生这方面的能力上，可谓用心良苦。

除了上述两个特点外，该书在内容上也有许多可圈可点之处。例如，在第2章的结合键中对过渡金属和陶瓷材料的混合键有清楚的分析；在第3章晶体结构中，对晶面指数和方向指数的表示作了极详尽的说明，这虽看似简单，但在教学上体会到必须做大量练习才能使学生牢固掌握；特别地，全书自始至终广泛引入现代材料科学的前沿课题，如对智能材料器件、MEMs、纳米材料、超级合金及其在生物医学应用方面等的首次介绍，使学生能够开阔眼界，紧跟潮流；大量精美的插图，强化了相关的内容，尤其是每章均引入压题照片，处处向学生表明材料科学与工程无处不在地应用于现实世界中。

本书可作为材料科学与工程专业教材，也可作为机械、动力类专业相应课程的教学参考书，对材料工程师和科技人员，也是一本有用的工具书。

石德珂

于西安交通大学

ABOUT THE AUTHORS

William F. Smith is 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 is a registered professional engineer in the states of California and Florida, has been teaching undergraduate and graduate materials science and engineering courses and actively writing textbooks for many years. He is also the author of *Structure and Properties of Engineering Alloys*, Second Edition (McGraw-Hill, 1993).

Javad Hashemi is a Professor of Mechanical Engineering at Texas Tech University, where he has taught introduction to materials science since 1991. Javad received his Ph.D. in Mechanical Engineering from Drexel University in 1988. Dr. Hashemi has been teaching undergraduate and graduate materials and mechanics courses, as well as laboratories at Texas Tech University. He is also the principal developer of the virtual laboratory modules accompanying this textbook as part of a pilot project funded by National Science Foundation. Dr. Hashemi's current research focus is the areas of materials, biomechanics, and education for engineers.

PREFACE

Foundations of Materials Science and Engineering, Fourth Edition is designed for a first course in materials science and engineering for engineering students. Understanding that this might be a student's first exposure to materials science, the book presents essential topics in a clear, concise manner, without extraneous details to overwhelm newcomers. Industrial examples and photographs used throughout the book give students a look at the many ways material science and engineering are applied in the real world.

NEW FEATURES OF THE FOURTH EDITION

In addition to its already renowned student friendly writing style and applications to industry, the fourth edition offers new features including a thorough coverage of modern materials science topics that prepare students for life outside the classroom. The new sections are:

- New reference to smart materials/devices, MEMs, and nanomaterials (1.1)
- New reference to superalloys and their biomedical applications (1.3)
- Added discussion of engineering plastics and applications in automobiles (1.3.2)
- Added discussion of engineering ceramics and applications (1.3.3)
- Added discussion of composite materials (1.3.4)
- New coverage of smart materials and nanomaterials (1.5)
- New section featuring a simplified case study in selection of materials for the frame and forks of a bicycle (1.6)
- New coverage of amorphous materials was added in chapter 3
- Added references to long and short range order (SRO also known as amorphous materials) (3.1)
- Chapter 4 has been split into chapters 4 and 5 for the fourth edition so diffusion can be covered in a stand-alone chapter
- Coverage of microscopes added to the end of chapter 4
- Added coverage of planar defects and twin boundaries (4.4.3)
- New section on volume defects (4.4.4)
- New section on experimental techniques for identification of microstructure and defects (4.5)
- Added coverage of fine-grained metals and the Hall-Petch equation in chapter 6
- New case study in failure and coverage of recent advances in improving mechanical performance in chapter 7

- Added coverage of failure and fracture of metals (7.1)
- New section on ductile to brittle transition temperature (7.1.4)
- New section on recent advances and future directions in improving the mechanical performance of metals (7.7)
- New coverage of cooling curves in chapter 8
- Added coverage of intermediate compounds (8.11.1)
- Three new sections devoted to advanced alloys and their application in biomedical engineering have been added to chapter 9
- New section devoted to biomedical applications of polymeric materials added to chapter 10
- New section with coverage of bucky balls and carbon nano-tubes (11.2.12)
- New section on ceramic coatings and surface engineering (11.9)
- New section on ceramics in biomedical applications (11.10)
- New section on nanotechnology and ceramics (11.11)
- New section on bone: a natural composite material (12.9)
- New section on hydrogen damage (13.5.11)
- New section on nanoelectronics (14.9)
- New appendix featuring extensive materials properties reference

Other New Features:

- Learning objectives have been added to every chapter
- Icons have been added to highlight the supplemental media resources
- Many new chapter openers and interior photos are included

Retained Features:

- Over 1200 end-of-chapter problems and over 180 materials selection and design problems are offered
- Over 140 example problems
- Modern applications of materials
- A concise, readable style is used throughout; readers are given understandable explanations without excessive detail

SUPPLEMENTS

Student CD-ROM

There is a new student CD-ROM to accompany the fourth edition of *Foundations of Materials Science and Engineering* featuring a wealth of visualization and study materials.

- Three Virtual Labs, with video, interactive quizzing, and step-by-step real-life processes (with possible pitfalls), are included to better prepare students for the laboratory or serve as a simulation of an actual laboratory experience for

students. Lab topics: Measurement of Hardness Using Rockwell Hardness test, Metallography, Tensile Testing.

- An extensive lab manual in PDF and Word formats coordinates with the Virtual Labs.
- MatVis is 2.0 crystal visualization software allows students to create different crystal structures and molecules, as well as view already created structures.
- ICENine Phase Diagram software allows students to search a list of phase diagrams and find the composition at any given temperature.
- EES (Engineering Equation Solver) computational software provides students with capability to solve materials science problems.
- Animations cover bonds, bond forces, rotating crystals, atomic packing arrangements, different crystal planes and coordination members, among other topics. Likewise, tutorials with sound are provided.
- Extensive, searchable materials properties database.
- Bonus chapters on “Materials for MEMS and Microsystems,” a chapter from Tai-Ran Hsu’s *MEMS and Microsystems: Design and Manufacture*.
- Numerous web links to professional sites and reference materials

Instructor’s Resource CD-ROM

- Lecture PowerPoint slides with added animations, videos, and images not included in the text
- Text images in Jpeg format
- Solutions manual in PDF and Word formats
- Teaching resources to help instructors incorporate the Virtual Labs and other media into their course
- Lab manual to accompany the Virtual Labs
- Sample syllabi
- Transition guides to help instructors transition from their current text to the fourth edition of Smith/Hashemi

COSMOS CD-ROM for Instructors The detailed solutions for all text problems are delivered in our new electronic Complete Online Solutions Manual Organization System. COSMOS is a database management tool geared towards assembling homework assignments, tests and quizzes. No longer do instructors need to wade through thick solutions manuals or huge Word files. COSMOS helps them to quickly find solutions, and also keeps a record of problems assigned to avoid duplication in subsequent semesters. Instructors can contact their McGraw-Hill sales representative at www.mhhe.com/catalogs/rep/ to obtain a copy of the COSMOS solutions manual.

Online Learning Center Web support is provided for the book at the website www.mhhe.com/smithmaterials. Visit this site for book and supplement information, errata, author information, and resources for further study or reference.

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