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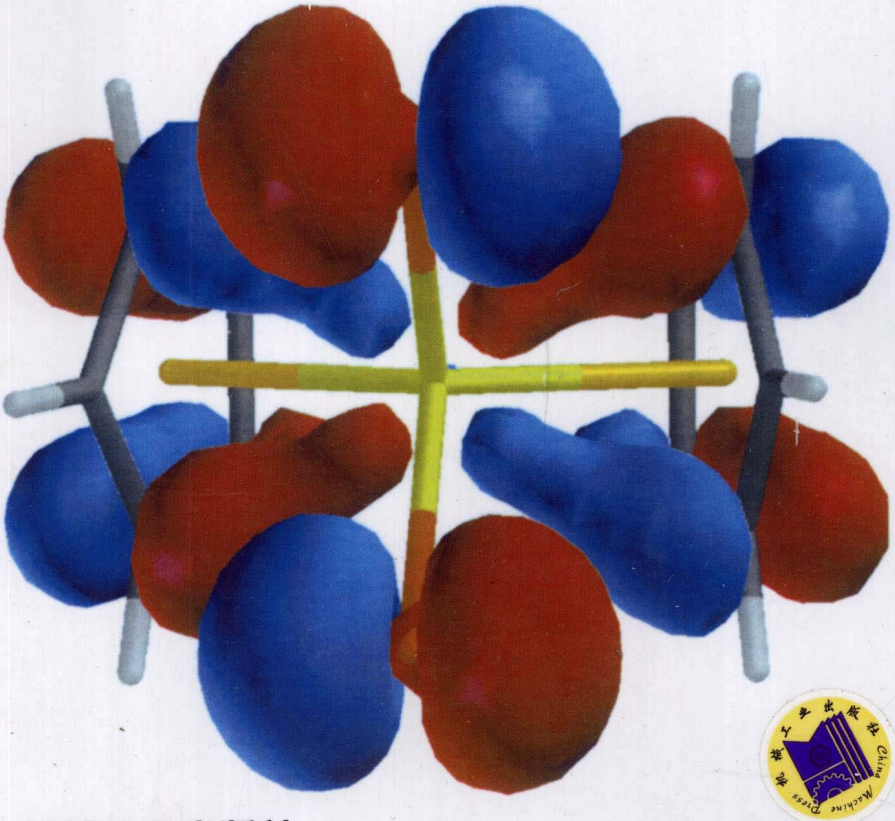
高分子科学与工程

Polymer Science and Technology

（美） Joel R. Fried 著



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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作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与审再审，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，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。

机械工业出版社

影印版前言

《高分子科学与工程》第2版由 Joel. R. Fried 教授于2003年修订，是第1版的整体改版。这本书几乎包括了高分子科学领域的各个方面，如高分子合成化学、高分子物理、高分子加工以及高分子材料等，既有高分子合成与性能的基础理论知识介绍，也有高分子材料的最新发展；既有高分子材料在传统工程领域的应用，也引入了高分子材料在一些特殊领域如分离、药物释放以及光电领域的应用实例。通过本书的阅读，读者可以全面了解高分子材料的合成、结构和性能的关系、加工以及应用等方面的系统知识，是一本全面介绍高分子材料科学与工程相关基础知识的教科书。

本书共12章，第1～7章主要讨论了高分子的合成与性质，第8～10章详细介绍了不同种类的通用和高性能高分子材料，第11章是高分子材料的加工和流变学概论，第12章则介绍了用于气体分离或阻隔、光、电、生物医学和药物释放等领域的特种高分子材料。从全书内容安排可以看出，本书的最大特点是系统而全面地介绍了高分子科学的各个重要领域，它既包括了高分子材料的合成及高分子在溶液、熔体、橡胶态和固态时的各种性质，同时还涵盖了高分子的基本加工原理，以及高分子在医药、生物技术、化工和电子等行业中的最新应用，并详细讨论了各种高分子材料如热塑性和热固性塑料、橡胶、纤维、先进工程塑料及高分子共混材料的结构和性能等。

此外，在第1版的基础上，第2版教材还增加了许多高分子科学领域的最新研究成果，包括原子转移自由基聚合、等离子体聚合、超临界流体在聚合反应中的应用、动态热分析技术（温度调制 DSC）、生物降解高分子、纳米复合材料、树枝状和超枝化高分子等，同时每章还增加了许多实例、附有重要的参考文献和习题思考题等，有利于读者学习和巩固。

总之，本书不仅介绍了高分子科学技术的各个领域，而且还介绍了高分子科学研究的各种物理、化学方法和表征手段，是一本能较好地适合化工、化学和材料科学与工程专业本科生和研究生学习的教材，特别是在国内目前所倡导的宽口径、大专业培养的教育背景下，本教材有利于材料科学与工程或其他工程类专业的大学生，全面而完整地了解高分子科学与工程方面的知识和最新进展，并对化工行业的技术人员也有很好的启迪和参考价值。相信本书的引进出版对我国高分子科学技术的教学定能起到积极的促进作用。

杨继萍

于北京航空航天大学

PREFACE

The Second Edition provides new and expanded coverage of important topics in polymer science and engineering and includes additional example calculations, homework problems, and bibliographic references. Additional topics in the treatment of polymer synthesis (Chapter 2) include metallocene catalysis, atom transfer radical and plasma polymerization, the genetic engineering of polymers, and the use of supercritical fluids as a polymerization medium. The new field of dynamic calorimetry (temperature-modulated DSC) has been added to the coverage of polymer viscoelasticity in Chapter 5. Chapter 6 provides expanded coverage of biodegradable polymers while Chapter 7 introduces the important new area of nanocomposites. Chapter 8 has been totally revised to include coverage of biopolymers and naturally occurring polymers including chitin and chitosan, while material on commodity thermoplastics has been moved to Chapter 9. In Chapter 10, new engineering and specialty thermoplastics including dendrimers, hyperbranched polymers, and amorphous Teflon are discussed. Examples of polymer processing modeling have been expanded to include wire-coating operations in Chapter 11. The topic of drag reduction has been moved from Chapter 12 to the coverage of polymer rheology in Chapter 11 which now also includes an introduction to melt instabilities. The discussion of the electrical and optical applications of engineering polymers has been enhanced and new coverage of barrier polymers has been provided in Chapter 12.

Although the intended audience for this text is advanced undergraduates and graduate students in chemical engineering, the coverage of polymer science fundamentals (Chapters 1 through 5) is suitable for a semester course in a materials science or chemistry curriculum. Chapters 6 and 7 discuss more specialized topics such as polymer degradation, recycling, biopolymers, natural polymers, and fibers. Sections from this coverage can be included to supplement the basic coverage provided by the earlier chapters. Chapters 9 and 10 survey the

principal categories of polymers—commodity thermoplastics, elastomers, thermosets, and engineering and specialty polymers. Material from these chapters may be included to supplement and reinforce the material presented in the chapters on fundamentals and provides a useful reference source for practicing scientists and engineers in the plastics industry. Polymer engineering principles including rheology and processing operations, introduced in Chapter 11, can be used as the basis of a short course on polymer engineering at the senior undergraduate and graduate student level. Chapter 12 describes polymers used in areas of advanced technology including membrane separations, electrolytes for batteries and fuel cells, controlled drug release, nonlinear optical applications, and light-emitting diodes and displays. This coverage may be used as reference material for scientists and engineers and provides a basis for short courses in such areas as membrane science and technology and polymer physics.

Joel R. Fried
Cincinnati, Ohio

PREFACE TO THE FIRST EDITION

At least dozens of good introductory textbooks on polymer science and engineering are now available. Why then has yet another book been written? The decision was based on my belief that none of the available texts fully addresses the needs of students in chemical engineering. It is not that chemical engineers are a rare breed, but rather that they have special training in areas of thermodynamics and transport phenomena that is seldom challenged by texts designed primarily for students of chemistry or materials science. This has been a frustration of mine and of many of my students for the past 15 years during which I have taught an introductory course, *Polymer Technology*, to some 350 chemical engineering seniors. In response to this perceived need, I had written nine review articles that appeared in the SPE publication *Plastics Engineering* from 1982 to 1984. These served as hard copy for my students to supplement their classroom notes but fell short of a complete solution.

In writing this text, it was my objective to first provide the basic building blocks of polymer science and engineering by coverage of fundamental polymer chemistry and materials topics given in Chapters 1 through 7. As a supplement to the traditional coverage of polymer thermodynamics, extensive discussion of phase equilibria, equation-of-state theories, and UNIFAC has been included in Chapter 3. Coverage of rheology, including the use of constitutive equations and the modeling of simple flow geometries, and the fundamentals of polymer processing operations are given in Chapter 11. Finally, I wanted to provide information on the exciting new materials now available and the emerging areas of technological growth that could motivate a new generation of scientists and engineers. For this reason, engineering and specialty polymers are surveyed in Chapter 10 and important new applications for polymers in separations (membrane separations), electronics (conducting polymers), bio-

technology (controlled drug release), and other specialized areas of engineering are given in Chapter 12. In all, this has been an ambitious undertaking and I hope that I have succeeded in at least some of these goals.

Although the intended audience for this text is advanced undergraduates and graduate students in chemical engineering, the coverage of polymer science fundamentals (Chapters 1 through 7) should be suitable for a semester course in a materials science or chemistry curriculum. Chapters 8 through 10 intended as survey chapters of the principal categories of polymers—commodity thermoplastics and fibers, network polymers (elastomers and thermosets), and engineering and specialty polymers—may be included to supplement and reinforce the material presented in the chapters on fundamentals and should serve as a useful reference source for the practicing scientist or engineer in the plastics industry.

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I wish to also thank those colleagues who kindly provided some key illustrations and photos. These are Dr. Roger Kambour of General Electric, Professor Bill Koros of the Georgia Institute of Technology, Professor Paul Han of the University of Akron, Professor John Gilham of Princeton University, Professor Paul Philips of the University of Tennessee, Dr. Marty Matsuo of Nippon Zeon (Japan), Dr. Robert Cieslinski of The Dow Chemical Company, Dr. Richard Baker of Membrane Technology & Research, Inc., Dr. Mostafa Aboulfaraj of Pechiney Centre de Recherches de Voreppe (France), Professor Morton Denn of the City College of New York, and Professor David Tirrell of the California Institute of Technology.

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