

Preface

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Materials Science of Polymers for Engineers

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Preface to the First Edition

This book is designed to provide a polymer materials science background to engineering students and practicing engineers. It is written on an intermediate level for students, and as an introduction to polymer materials science for engineers. The book presents enough information that, in conjunction with a good design background, it will enable the engineer to design polymer components.

Materials Science of Polymers for Engineers is based on the German textbook, *Werkstoffkunde Kunststoffe* (G. Menges, Hanser Publishers, 1989), and on lecture notes from polymer materials science courses taught at the Technical University of Aachen, Germany, and at the University of Wisconsin-Madison.

The chapters on thermal and electrical properties are loose translations from *Werkstoffkunde Kunststoffe*, and many figures throughout the manuscript were taken from this book. We have chosen a unified approach and have divided the book into three major sections: Basic Principles, Influence of Processing on Properties, and Engineering Design Properties. This approach is often referred to as the four P's: polymer, processing, product and performance. The first section covers general topics such as historical background, basic material properties, molecular structure of polymers and thermal properties of polymers. The second section ties processing and design by discussing the effects of processing on properties of the final polymer component. Here, we introduce the reader to the rheology of polymer melts, mixing of polymer blends, development of anisotropy during processing and solidification processes. In essence, in this section we go from the melt (rheology) to the finished product (solidification). The third section covers the different properties that need to be considered when designing a polymer component, and analyzing its performance. These properties include mechanical properties, failure of polymers, electrical properties, optical properties, acoustic properties, and permeability of polymers. The authors cannot acknowledge everyone who helped in one way or another in the preparation of this manuscript. We would like to thank the students of our polymer materials science courses who in the past few years endured our experimenting and trying out of new ideas. The authors are grateful to the staff and faculty of the Mechanical Engineering Department at the University of Wisconsin-Madison, and the Institut für Kunststoffverarbeitung (IKV) at the Technical University of Aachen for their support while developing the courses which gave the base for this book. We

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Preface to the Third Edition

The first edition of this book was adopted by several universities in North and South America, Europe, and Asia as a textbook to introduce engineering students to the materials science of polymers. The book was also translated into Japanese, Korean, and Spanish. The professors who taught with the first and second editions as well as their students liked the unified approach we took. The changes and additions in this edition are based on suggestions from these professors and their students, as well as from our own experience using it as a class textbook.

After two revisions and two decades of teaching it has become clear that sustainability and profits are important when dealing with polymeric materials. Therefore the 4P's of the first edition have expanded to the 6P's in the third edition: polymer, processing, product, performance, post-consumer life, and profit. The first and second editions were praised because of the vast number of graphs and data that can be used as references. We have further strengthened this attribute by expanding a comprehensive table in the appendix that contains material property graphs for several polymers. Furthermore, in this edition we added color to the figures and graphs, making the book more appealing to the reader.

With this edition we owe our gratitude to Dr. Christine Strohm for editing the book and catching those small typos and inconsistencies in the text and equations. We thank Dr. Nadine Warkotsch and Steffen Joerg of Hanser Publishers for their cooperation during the production of this book. We are grateful to Luz Mayed D. Noguez and Tobias Mattner for the superb job drawing the figures, and to Tobias Mattner for his suggestions on how to make many of the figures more understandable. A special thanks to Katerina Sánchez for the graphs related to recycling of plastics in Chapter 1 and to Nora Catalina Restrepo for generating the polymer statistic graphs in Chapter 2. My graduate students Roberto Monroy, Luisa López, Tom Mulholland, Jakob Onken, Camilo Pérez, Daniel Ramírez, Jochen Wellekoetter and Yuxiao Zhang, organized by William Aquite, supplied extra problems and solutions for the third edition; thank you. Special thanks to Diane for – as always – serving as a sounding board and advisor during this project.

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