Preface

The intention of this book is to create a modern review of polymer mechanics theory. This includes explaining how experimental characterization and material modeling are interconnected and can be used to guide accurate finite element predictions of all types of polymers (elastomers, thermoplastics, thermosets, biomaterials, etc.). After finishing my Ph.D. research at MIT in the area of modeling the large strain time-dependent response of elastomers, I have spent the last 16 years as a technical consultant helping companies better understand their polymer products and become more competitive. As part of this effort, I realized early on that there is a huge need for better training and computational tools when it comes to understanding the commonly observed non-linearities of polymer behaviors. To help fill this gap I created the popular website https://PolymerFEM.com, which is a free forum for advanced testing and modeling of polymers. I have also given a large number of short courses for professional designers, engineers, and material scientists in various topics related to computational polymer mechanics. This book is the result of combining all of these different areas into a text that is suitable for students, researchers, and industrial engineers.

The topics that are covered in this book include experimental testing, simple material models (e.g. hyperelasticity, linear viscoelasticity, plasticity), and advanced non-linear viscoplastic models. For each topic, details of the theory are presented, and many examples of when and how the models can be applied to solve real problems are shown. As sometimes the theory can seem abstract, I have included a large number of code examples (mainly in the scripting language Python) illustrating in a concrete way the essence of the equations. All of the code is provided on the website for the book: http://PolymerMechanics.com.

The overall goal for this book is to provide essential information about how different polymers behave and how their mechanical response can be represented in a finite element simulation.

This field of research is now sufficiently mature that virtually all polymers can be accurately simulated, if you use an appropriate material model. Finally, as I say at the end of all my classes, I work in this field because I really enjoy it. I encourage you to reach out to me if you have any questions or comments.

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