

Preface

Viscoelasticity or rheology is important in polymer science and engineering because it plays a crucial role in production and characterization of polymeric materials. Understanding the viscoelasticity of polymers requires knowledge of various disciplines such as continuum mechanics, thermodynamics, advanced applied mathematics, polymer physics, and statistical mechanics. Rheology of polymers is studied by the researchers from various fields such as polymer scientists, mechanical engineers, chemical engineers, physicists, and chemists. Hence, it is hard to expect that a newcomer to the field of polymer viscoelasticity would be familiar with such diverse disciplines. From this viewpoint, one may feel the necessity of a book which addresses basic sciences for polymer viscoelasticity as possible as many. Examples of such comprehensive books of rheology are “Dynamics of Polymeric Liquids, volume I and II” written by Bird and coauthors, and “Engineering Rheology” written by Tanner. The book of Bird and coauthors does not contain numerical methods for nonlinear viscoelastic flows while the book of Tanner deals with it. Even though both books are comprehensive rheology books, in the author’s opinion, the former is focused on development of constitutive equation while the latter is oriented to the application of constitutive equation to polymer processing. Because it is practically impossible to write a comprehensive book of rheology which contains everything of rheology, most famous books of rheology have their own orientation indicating authors’ expertise, with addressing sufficient amount of basic knowledges. The author intends to write a comprehensive rheology book with the orientation to the identification of the rheological properties of polymers from their experimental data. This has been one of the themes of the author’s research for recent 10 years.

Any single book cannot satisfy all readers because each reader has different backgrounds and different maturity in their knowledge. When the author was a master-degree student, he thought that Larson’s book, “Constitutive Equations of Polymer Melts and Solutions,” is not good because it is so compact. However, when he read the book after his Ph.D., he recognized that it is one of well-made rheology books. The present book assumes the readers to have strong background

of engineering mathematics of undergraduate level. The readers do not have to be familiar with tensor analysis because it is given in the book. This book is designed for experimental rheologists, who are strong in mathematics, as well as for students, who want to be familiar with theoretical rheology.

The book consists of three parts. The first part provides fundamental principles which should be necessary to understand the other parts: linear and nonlinear viscoelasticity. This part briefly addresses necessary mathematics, continuum mechanics and thermodynamics, statistical mechanics and polymer physics.

As the book is oriented to the rheological identification of polymers from the experimental data, the second part of linear viscoelasticity contains basic numerical methods which are useful for viscoelastic spectrum, time-temperature superposition, and application of linear viscoelastic principles to polymeric systems. Different from previous rheology books, this part is devoted to numerical algorithms of data processing which is expected to be helpful for experimentalists.

The last part starts from theory of nonlinear constitutive equation in order to explain large amplitude oscillatory shear (LAOS). The last chapter on LAOS is one of the most remarkable features of this book which makes the book different from previous well-made books of rheology.

The author appreciates for the help of a number of persons: his teachers, colleagues, students, and family. Without their help, this book could not have been written. Professor Jinyoung Park, Dongchoon Hyun, Dongyoon Lee, and Dr. Jung-Eun Bae are thankful for the review of the manuscript. Several parts of the book have resulted from the research with my old student, Dr. Jung-Eun Bae. Work cannot be in isolation. The author owes the present work to his teachers who taught him. Especially, Prof. Sangyong Kim made him to recognize the pleasure of academic career. The author cannot forget his students because his research results included in the book cannot be obtained without their assistance. This book was supported by Kyungpook National University Research Fund 2011.

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Theory and Numerical Algorithms

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