

Energy Landscapes also offers readers a survey of dynamical and statistical mechanical techniques for exploration of structural transformations and thermal properties as defined by the features of the underlying potential or free energy surfaces. Applications and illustrations are given for three types of systems: clusters, biomolecules, and glasses.

The first three chapters are aimed at those who are at the beginning of the road. As an introduction to the main subject, they sketch methods used to compute potential energy surfaces, introduce issues relevant to systems discussed later, review the essence of the Born–Oppenheimer approximation and the normal modes, and present an overview of the role of symmetry. The seven chapters that follow focus on the central subject of energy landscapes and their applications and discuss a variety of other issues, including those of general conceptual and methodological nature. Among the latter are phases and phase changes in finite systems, and scaling laws.

The book is theoretical, with some mention of the relevant key experimental findings. Its scope is extensive; as a consequence, not all the subjects are covered with equal detail. Some associated issues—for example, fitting potential energy surfaces and the effect of rotation on potential energy landscapes—are not touched upon at all. The author might consider including these topics in the second edition. The balance between the formal mathematical and descriptive parts is about right for the intended broad readership, from graduate students to experts. The main value of the book lies in its being a rich resource that captures the current status of its subject matter. The style and presentation are engaging and the excellent illustrations, many in beautiful color, only heighten curiosity and enhance the desire to read on. The extensive lists of references at the end of each chapter will lead the inquiring reader to the original literature.

Energy Landscapes will be invaluable, as a roadmap and guide, to both novices and the seasoned in the expanding group of explorers of energy landscapes. University professors will find it most useful in introducing the subject to their students.

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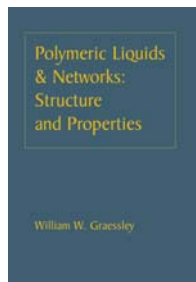
Polymeric Liquids and Networks: Structure and Properties

William W. Graessley
Garland Science, New York, 2004.
\$84.95 (559 pp.).
ISBN 0-8153-4169-5

Polymer science by its very nature is an interdisciplinary field that has attracted many researchers. It uses methods that range from the practical fields of synthetic chemistry, engineering, and biology to the more theoretically oriented fields of high-energy physics and condensed matter physics. Many people who call themselves polymer scientists started their careers with classic training in chemistry, biology, physics, or mathematics but find themselves confronted with problems of polymer science in their projects as industrial scientists or engineers. Academic researchers often drift into the field, drawn by the many interesting phenomena that arise in these materials, the deep and beautiful mathematics invoked to explain these phenomena, and, of course, the prospect of fundable basic research.

Given the constantly evolving nature of polymer science and its diverse practitioners, it is difficult to construct a unified description of its basic concepts and phenomenology. In *Polymeric Liquids and Networks: Structure and Properties*, William Graessley approaches the problem by addressing his book to a specific audience—industrial engineers and research scientists trying to learn about polymer science in the course of their applied work, education, or research in allied fields. He makes the task more manageable by confining his treatment to synthetic polymers of well-defined molecular architectures, and by avoiding the many complexities of glass formation in polymer liquids.

Graessley, a professor emeritus in Princeton University's chemical engineering department, is perhaps best known for his studies on the rheological flow and dynamical–mechanical properties of polymer fluids. His new book, however, focuses primarily on the equilibrium properties of polymeric fluids as a foundation for understanding their dynamics. The author is preparing a second book, which will focus on the rich phenomenology of the dynamics of these complex fluids.



The attractive feature of *Polymeric Liquids and Networks* is that it starts from an elementary viewpoint emphasizing molecular chemical structure. Graessley then integrates this chemistry-dominated description with one that focuses on the universal properties of polymers that are the primary concern of physicists and mathematicians. The universal properties derive from chain connectivity, topology (ring, star, and comb—for example), and the existence of well-defined random processes that govern the conformations of polymers at equilibrium. Due attention is also given to the polydispersity of chain structure and mass, as well as other topics of practical interest to engineers and materials scientists. In the course of his interdisciplinary discussion, Graessley introduces coarse-grained models of polymers and a wide range of theoretical concepts. This broad approach is made credible by a wealth of data for numerous polymer fluids, data that support the polymer science principles introduced earlier.

Polymeric Liquids and Networks seems to be organized as a field guide to polymer science, with extended sections on matters of personal interest and engineering importance. Graessley covers statistical thermodynamics in a few pages and concisely describes some essentials of scattering theory required for reading the modern polymer-science literature. He also introduces various liquid-state models of polymer fluids and some of the important ideas behind them. The remaining chapters, which are perhaps the most novel aspect of the book, attempt to digest information from the vast field of network theory. In those chapters, Graessley discusses diverse models of network elasticity and the results of key experimental studies. Readers should be impressed by the extent to which the author reveals the gaps in our knowledge in this important area. His critical review of network elasticity theory and measurements will no doubt attract new researchers to this classic area of polymer science.

Despite the brevity and impressionistic nature of many of the remaining chapters, the author manages to work in several comments about the history of the ideas presented. His discussions are often augmented by the strategic use of references for topics that are only briefly treated or beyond his area of expertise.

Concepts covered in the book include random-walk and wormlike

chain models of polymers, the notions of a polymer-overlap concentration and screening of excluded volume interactions, topological interactions, free-draining versus nonpenetrating hydrodynamic interactions of polymer chains, definitions of branched polymer types, and mean-field network theories. In addition to offering general tutorials on core polymer science concepts, Graessley dwells on topics of particular interest to engineering polymer scientists and on areas of research to which he has contributed. For example, he devotes much space to the equation-of-state description of the thermodynamic properties of polymer liquids. He also covers in detail the theoretical attempts to understand the solubility of polymer blends based on measurements of cohesive energy densities, or solubility parameters, in conjunction with the Flory-Huggins model of the free energy of mixing polymer fluids.

Moreover, Graessley offers an extended and clear discussion of the dilute-solution properties of polymers that includes his experimental contributions to this basic area of polymer science. His treatment of dilute-solution properties simultaneously considers this problem from the standpoint of testing theoretical under-

standing of polymer structure-property relationships, and as a source of information about polymer interactions. Thus, practical experimental methodologies are emphasized in addition to theoretical models and their validation. Examples of the experimental methodologies include plotting procedures to deduce virial coefficients from scattering, viscosity, and diffusion data; observing the comparative advantages of neutron and light scattering from such plotting procedures; and using chromatography for polymer characterization and universal calibration.

In summary, *Polymeric Liquids and Networks* manages to capture much of the conventional wisdom of the science of synthetic polymers and highlights some of the rich phenomenology of polymer networks and theories attempting to describe those observations. The text is a wealth of information on the more technical matters of characterizing the structure and interactions of polymer solutions and understanding the miscibility of polymer blends in terms of polymer structural properties and measures of interpolymer interaction. The book should be a valuable resource for newcomers who are trying to understand essential concepts of

polymer science, learn some of the history of the field, and find direction for further reading.

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