The Phenomenological Theory Of Linear Viscoelastic Behavior An Introduction

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Then it seems as if we have to think about time not in this linear way, and I like that ... the interest in reading this kind of critical theory. I ’ ve started to think that maybe the memories ...

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One of the principal objects of theoretical research in any department of knowledge is to find the point of view from which the subject appears in its greatest simplicity. J. Willard Gibbs This book is an outgrowth of lectures I have given, on and off over some sixteen years, in graduate courses at the California Institute of Technology, and, in abbreviated form, elsewhere. It is, nevertheless, not meant to be a textbook. I have aimed at a full exposition of the phenomenological theory of linear viscoelastic behavior for the use of the practicing scientist or engineer as well as the academic teacher or student. The book is thus primarily a reference work. In accord with the motto above, I have chosen to describe the theory of linear viscoelastic behavior through the use of the Laplace transformation. The treatment oflinear time-dependent systems in terms of the Laplace transforms of the relations between the excitation add response variables has by now become commonplace in other fields. With some notable exceptions, it has not been widely used in viscoelasticity. I hope that the reader will find this approach useful.

An Introduction to the Phenomenological Theory of Ferroelectricity covers topics about the basis and derivation of the macroscopic or phenomenological theory of the elastic, dielectric and thermal properties of crystals as applied in the field of ferroelectricity. The monograph discusses the elastic, dielectric, and thermal properties of ferroelectric crystals; the standard linear time-dependent electroelastic theory; the non-linear static properties of an elastic dielectric on a variational principle; and the phenomenological theory of the static thermal, elastic, and dielectric properties of a homogeneous material. The book also describes the theory of the static non-linear behavior of an elastic dielectric as well as the phenomenological models for ferroelectricity. Students taking physics courses and practicing physicists will find the book invaluable.

As a reference book, the Springer Handbook provides a comprehensive exposition of the techniques and tools of experimental mechanics. An informative introduction to each topic is provided, which advises the reader on suitable techniques for practical applications. New topics include biological materials, MEMS and NEMS, nanoindentation, digital photomechanics, photoacoustic characterization, and atomic force microscopy in experimental solid mechanics. Written and compiled by internationally renowned experts in the field, this book is a timely, updated reference for both practitioners and researchers in science and engineering.

This work sets out to provide an up-to-date account of the physical properties and structure of polymers in the glassy state. Properties measured above the glass transition temperature are therefore included only in so far as is necessary for the treatment of the glass transition process. This approach to the subject therefore excludes any detailed account of rubber elasticity or melt rheology or of the structure and conformation of the long chain molecule in solution, although knowledge derived from this field is assumed where required. Major emphasis is placed on structural and mechanical properties, although a number of other physical properties are included. Naturally the different authors contributing to the book write mainly from their own particular points of view and where there are several widely accepted theoretical approaches to a subject, these are sometimes provided in different chapters which will necessarily overlap to a significant extent. For example, the main theoretical presentation on the subject of glass transition is given in Chapter 1. This is supplemented by accounts of the free volume theory in Chapter 3 and in the Introduction, and a short account of the work of Gibbs and DiMarzio, also in Chapter 3. Similarly, there is material on solvent cracking in Chapters 7 and 9, though the two workers approach the subject from opposite directions. Every effort has therefore been made to encourage crossreferencing between different chapters.

Viscoelastic behavior reflects the combined viscous and elastic responses, under mechanical stress, of materials which are intermediate between liquids and solids in character. Polymers the basic materials of the rubber and plastic industries and important to the textile, petroleum, automobile, paper, and pharmaceutical industries as well exhibit viscoelasticity to a pronounced degree. Their viscoelastic properties determine the mechanical performance of the final products of these industries, and also the success of processing methods at intermediate stages of production. Viscoelastic Properties of Polymers examines, in detail, the effects of the many variables on which the basic viscoelastic properties depend. These include temperature, pressure, and time; polymer chemical composition, molecular weight and weight distribution, branching and crystallinity; dilution with solvents or plasticizers; and mixture with other materials to form composite systems. With guidance by molecular theory, the dependence of viscoelastic properties on these variables can be simplified by introducing certain ancillary concepts such as the fractional free volume, the monomeric friction coefficient, and the spacing between entanglement loci, to provide a qualitative understanding and in many cases a quantitative prediction of how to achieve desired results. The phenomenological theory of viscoelasticity which permits interrelation of the results of different types of experiments is presented first, with many useful approximation procedures for calculations given. A wide variety of experimental methods is then described, with critical evaluation of their applicability to polymeric materials of different consistencies and in different regions of the time scale (or, for oscillating deformations, the frequency scale). A review of the present state of molecular theory follows, so that viscoelasticity can be related to the motions of flexible polymer molecules and their entanglements and network junctions. The dependence of viscoestic properties on temperature and pressure, and its descriptions using reduced variables, are discussed in detail. Several chapters are then devoted to the dependence of viscoelastic properties on chemical composition, molecular weight, presence of diluents, and other features, for several characteristic classes of polymer materials. Finally, a few examples are given to illustrate the many potential applications of these principles to practical problems in the processing and use of rubbers, plastics, and fibers, and in the control of vibration and noise. The third edition has been brought up to date to reflect the important developments, in a decade of exceptionally active research, which have led to a wider use of polymers, and a wider recognition of the importance and range of application of viscoelastic properties. Additional data have been incorporated, and the book s chapters on dilute solutions, theory of undiluted polymers, plateau and terminal zones, cross-linked polymers, and concentrated solutions have been extensively rewritten to take into account new theories and new experimental results. Technical managers and research workers in the wide range of industries in which polymers play an important role will find that the book provides basic information for practical applications, and graduate students in chemistry and engineering will find, in its illustrations with real data and real numbers, an accessible introduction to the principles of viscoelasticity.

Theory of Electric Polarization, Volume II: Dielectrics in Time-Dependent Fields focuses on the processes, reactions, and principles involved in the application of dielectrics in time-dependent fields, as well as the Kerr effect, statistical mechanics, and polarization. The publication first examines the phenomenological theory of linear dielectrics in time-dependent fields; empirical description of dielectric relaxation; and the relationship between macroscopic and molecular dielectric relaxation behavior. Concerns cover the relationship between macroscopic and microscopic correlation functions; statistical mechanics of linear dissipative systems and the relationship between response functions and correlation functions; superpositions of distribution functions; and the use of complex dielectric constant in problems with time-dependent field sources. The book then ponders on the dipole correlation function, polarization in the infrared and optical frequency range, and the Kerr effect and related phenomena. Discussions focus on the Kerr effect in condensed systems, extensions of the Kerr effect, extrapolation of the refractive index to infinite wavelength, results obtained from computer simulations, rotational diffusion, and general aspects of molecular reorientation. The manuscript tackles the dielectric properties of molecular solids and liquid crystals and experimental determination of permanent dipole and quadrupole moments. The text is a valuable source of data for researchers interested in the application of dielectrics in time-dependent fields.

This volume on structural fire resistance is for aerospace, structural, and fire prevention engineers; architects, and educators. It bridges the gap between prescriptive- and performance-based methods and simplifies very complex and comprehensive computer analyses to the point that the structural fire resistance and high temperature creep deformations will have a simple, approximate analytical expression that can be used in structural analysis and design. The book emphasizes methods of the theory of engineering creep (stress-strain diagrams) and mathematical operations quite distinct from those of solid mechanics absent high-temperature creep deformations, in particular the classical theory of elasticity and structural engineering. Dr. Razdolsky ’ s previous books focused on methods of computing the ultimate structural design load to the different fire scenarios. The current work is devoted to the computing of the estimated ultimate resistance of the structure taking into account the effect of high temperature creep deformations. An essential resource for aerospace structural engineers who wish to improve their understanding of structure exposed to flare up temperatures and severe fires, the book also serves as a textbook for introductory courses in fire safety in civil or structural engineering programs, vital reading for the PhD students in aerospace fire protection and structural engineering, and a case study of a number of high-profile fires (the World Trade Center, Broadgate Phase 8, One Meridian Plaza; Mandarin Towers). Probability Based High Temperature Engineering: Creep and Structural Fire Resistance successfully bridges the information gap between aerospace, structural, and engineers; building inspectors, architects, and code officials.