In equation 9.176 the value of impedance looking into a capacitor, including the parasitic inductance for a system of unit width, is given by the ratio of the voltage to first order in $\omega$ and the current to second order. ($Z = (1/j\omega c)[1 - \omega^2 LC]$ with $C = \epsilon_0 lw/d$ and $L = \mu_0 ld/2w$.) The value of the parasitic inductance $L$ is incorrect. In order to obtain the proper value for the parasitic inductance one needs to use voltage correct to third order in frequency, a current correct to second order.

HERMANN A. HAUS
*MIT*
*Cambridge, Mass.*

## Introduction to Polymer Viscoelasticity

**John H. Aklonis, William J. MacKnight and Mitchel Shen**
249 pp. Wiley, New York, 1972. $14.95.

Polymeric substances find applications as engineering plastics and a still larger use as elastomers in such structures as automobile tires. When cross lengths between polymer molecules are absent, viscous liquids result. When long-chain polymer molecules are dissolved in a solvent the mechanical impedances of the solutions provide the best indications of the motions possible for polymer molecules.

There are a number of excellent books dealing with the subject. The authors point to the book by J. D. Ferry, *Viscoelastic Properties of Polymers*, as an exhaustive and complete exposition. They suggest that their book is justified as an introduction to this very complex subject and as a teaching treatise complete with problems.

The first several chapters discuss elasticity, viscosity, and viscoelasticity and rudimentary methods for measuring them. None of the more advanced methods involving low and high frequencies—such as discussed by Ferry—are mentioned. The regions possible in a polymer as a function of temperature and frequency are discussed in general terms. These regions are the glassy region, the transition region between the glassy and rubbery region and the two possible high-temperature regions depending on whether the chains are linear or cross linked. Cross-linked chains result in rubbers, whereas linear-chain molecules become viscous liquids at high temperatures and low frequencies.

The book discusses methods of obtaining a "master" curve from widely differing temperature and frequency measurements by using a "reduction" formula in which frequency, temperature, and density are related by certain shifting factors. The constants of this equation can be obtained from the free volume model of Williams, Landel, and Ferry (WLF). The reduction formula is stated as an axiom applicable at all frequencies and temperatures, whereas it is generally considered that there are limitations on its applicability.

For all three regions, the properties are discussed in terms of free-volume theory, thermodynamics, statistical theory, and various mechanisms—such as bond-angle restrictions—assumed to be present in the polymer molecules. The most complete discussion is for the rubbery state, where ideally the elasticity is similar to that of a gas with its elastic constant proportional to the absolute temperature and to the number of molecules per unit volume. Due to cross-linking between chains, the molecules cannot pass one another. This introduces an energy effect as well as an entropy effect, which is important for swelling-absorption of a solvent—and the use of fillers necessary for such applications as automobile tires.

BARNEY KROCHEK

**Tires** and certain engineering plastics use large amounts of polymeric substances.

The only complete treatments from a molecular point of view are the treatments of P. Rouse and B. Zimm on the properties of long-chain molecules in dilute solutions. Both treat the molecules as beads connected together by springs, acted on by the viscosity of the solvent. Rouse's treatment neglects any shielding of one molecule by another—the free draining model—whereas Zimm includes hydrodynamic shielding of one molecule by another. Reasonable agreement with experiment is obtained for both types of theories depending on the form of the molecules. By introducing certain types of assumptions these solutions have been applied to bulk polymers with moderate success.

Altogether, the book gives a good introduction to the complicated concepts of molecular viscoelasticity in the bulk phase of polymers. The introduction of problems for each chapter, with answers given in the appendix, makes the book a valuable teaching introduction to the subject.

WARREN P. MASON
*Columbia University*
*New York*

## Mathematical Physics, An Advanced Course

**S. G. Mikhlin**
561 pp. American Elsevier (North Holland), New York, 1971. $30.00

The title of this book is rather misleading. In his introduction, the author states that "Mathematical Physics can be regarded as an aspect of the general theory of Partial Differential Equations ... [this book] encompasses only the theory of linear partial differential equations, almost exclusively of the second order." Indeed, the reader will find little connection with modern mathematical physics; physical examples do not go beyond the vibrating membranes and similar material. In our opinion, this book should be retitled and evaluated as an "Intermediate Course in Linear Partial Differential Equations: Functional Analytic Approach."

Within these redefined bounds, the English edition of a book by S. G. Mikhlin is very commendable; it is clearly written, well within the elegant tradition of Mikhlin's previous textbooks on integral and singular integral equations. What distinguishes it is the strong use of concepts and methods of functional analysis, while priority is given to the study of differential equations of elliptic type.

In an introductory part, the book sketches the notion of generalized derivatives, and dwells on a lengthy review of the calculus of variations, with emphasis on quadratic functionals. However basic concepts of classical functional analysis that are used all through the text are not reviewed. Elements of the theory of Fredholm lin-

ear integral equations are elegantly summarized and abstracted in the theory of the eigenvalue spectrum of positive definite operators. The core of the book presents a remarkably thorough treatment of the classical theory of linear elliptic equations, and some classical potential theory. However, equations with variable coefficients and non self-adjoint equations are hastily sketched. There follows a shorter investigation of parabolic (heat-conduction) and hyperbolic (wave) equations, with emphasis on Fourier methods. An unusual feature is a chapter on properly and improperly composed problems in the field.

Surprisingly, a good knowledge of classical functional analysis is assumed from the reader. Because of this, one can only recommend the book to the most advanced physics graduate students. However, it does not deserve its title of "an advanced course" either. The applied mathematician will find that most contemporary ideas and results in partial differential equations are missing. Such important tools as generalized solutions and Sobolev spaces are barely sketched. Nonlinear problems (including the study of shocks) which are so prominent in today's applied mathematics, are ignored for all practical purposes.

To conclude, graduate students—and perhaps researchers in applied mathematics—will find it to be a handsome treatment of and reference for methods of classical partial differential equations.

DALJIT S. AHLUWALIA
*University of South Florida, Tampa*
BASIL NICOLAENKO
*New York University*



## Techniques of Chemistry, Vol. III: Photochromism

**G. H. Brown ed.**
853 pp. Interscience, New York, 1971. $47.50

After a short historical survey and outline of fundamental aspects of photochromism (the reversible process in which a solid changes color on exposure to light and thermal reverts to the original in the dark), the major portion of this thick, densely packed book deals with organic molecular photochromic transformations, their kinetics and spectral characteristics. Shorter chapters on inorganic solid-state photochromism, photochromic glasses and photochromism in living systems lead to the concluding chapter on applications.

After a decade of intense study spurred by support from both government and industrial sources, photochromics failed to achieve the broad utility initially envisioned. As stated in the last chapter describing chemical switches for computers, "The materials that showed a large spectral change in microseconds (the organic dyes in solution) generally exhibited pronounced fatigue. Those that showed negligible fatigue (solid inorganics and glasses) generally exhibited small, slow spectral changes." These limitations also retarded commercial utilization in other applications. With the present hiatus in activity, it is appropriate to take stock.

This book is a nearly perfect definitive record of photochromic accomplishments to date. The unevenness inevitable in a multi-authored text has been minimized by the care given to organization by the editor, Glenn H. Brown. The text is up-to-date with many references published in 1970. It contains detailed information in extensive tables of photochromic materials compiled from journal publications, patents and government and company reports. As a relatively small portion of the data has appeared in the journals, the book should be welcomed by