Book Reviews

Physical Aging in Amorphous Polymers and Other Materials

L. C. E. Struik

Elsevier, 1978

This book is mainly a summary of the extensive programme on the effects of aging at different temperatures below T_g on the properties of amorphous polymers, carried out by TNO at Delft. The dominant technique used was that of measuring changes in creep compliance. On these lines a mass of valuable data showing the fall in creep compliance with aging time is presented, which will be of great value to all those concerned with the properties and applications of glassy polymers. The work also provides substantial new evidence of the universality of the effect, which is shown to be characteristic of other organic glasses besides the high polymers. Other new results demonstrate the wide range of temperatures over which some degree of aging takes place. In line with other recent observations the TNO results show that large stresses leading to high creep rates or yielding can eliminate the previous cumulative aging processes.

Another interesting conclusion concerns the temperature range over which aging takes place, which is shown to be very different for different polymers. Evidence is presented that those polymers with long temperature ranges for ductility also have a wide range of temperatures where the aging (hardening) process may be observed. It is then suggested that the lower temperature limit both for aging and ductility is bounded by the β transition. However, here Baer [*J. Macromol. Sci. (B)* 1973, 137–679] has found that polycarbonate which has a β transition at 170K can show ductility down to 78K (which corresponds with another transition). Perhaps, after all the lower limit really depends on the test piece used.

At present there is no real consensus concerning the mechanism of the physical aging process in polymers. This book emphasises the role of volume relaxation and most workers would agree that this provides the most promising ground from which to approach the subject. This treatment naturally leads on to the consideration of various free volume treatments, all of which encounter difficulties. From the reviewers' personal standpoint, Dr. Struik seems to give too little emphasis to the free volume as originally defined by Doolittle (in line with much classical liquid theory and with the Simha–Boyer free volume) and too much attention to the well-known WLF disposable constant having the dimension of volume. No doubt it will be some time before all these matters are sorted out. In the meanwhile correlation of aging effect with volume changes is certainly a desirable objective.

These minor difficulties, which in view of the lack of general agreement over the aging mechanism cannot be regarded as criticism, do not detract from the great value of the experimental work provided and reviewed in this book. It should be required reading for anyone making physical measurements on thermoplastics.

R. N. Haward

Fractionation of Synthetic Polymers: Principles and Practices

Edited by L. H. Tung

Marcel Dekker, 1977, 760 pp, SFr 220

Lu Tung, the editor of this book, is well known to all who have been acquainted with the problem of fractionation and characterization of synthetic polymers. He has contributed again to this area of high polymer chemistry by drawing together eleven authors to produce seven reviews on important topics. They are as follows: Phase Equilibrium in Polymer Solutions, E. F. Casassa; Batch Fractionation, K. Kamide; Column Fractionation, E. M. Barrell and J. F. Johnson; Cloud Point and Turbidity Titrations, H. G. Elias; Fractionation of Copolymers, G. Riess & P. Callot; Gel Permeation Chromatography, L. H. Tung & J. C. Moore; Thin Layer Chromatography, H. Inagaki.

This volume will be read with interest by those who have some knowledge of the subject and by those recently entering the field. Within the range of the chosen topics it is very comprehensive in its treatment.

As an introduction, E. F. Casassa gives a clear and concise account of the thermodynamic principles necessary for theory underlying most of the subjects to follow in the book. It indicates clearly the assumptions necessary and the approximate nature of much of the theory. The topic of batch fractionation is treated in a theoretical fashion by the computer-simulated experiments presented by K. Kamide. The influence of every possible variable upon this type of experiment is calculated for succ3ssive precipitation and extraction. Theory indicates that fractional solution should be the most efficient method of batch fractionation. It contains a vast collection of numerical data. Barrall and Johnson deal with the topic of column fractionation from a very practical point of view. This older chromatographic technique still has value in many instances when gel permeation chromatography is not applicable.

The contribution by Elias relies heavily on the theories of polymer solutions in interpreting cloud point studies. This simple experimental technique can give valuable practical and theoretical information. The topic of copolymers arises in most contributions to this book but it is treated as a separate subject by Riess and Callot. This leads to some overlap of content but this item will be of considerable value to those with a deep interest in copolymers. Gel permeation chromatography is a vast subject. Tung and Moore do not attempt to cover the very large number of polymer systems to which this technique has been applied. Instead they concentrate upon the experimental aspects and the precise interpretation of chromatograms. Thin layer chromatography is per haps not generally associated with experimental work in the high polymer chemistry of synthetic materials.

The final contribution by Inagaki cites many examples where valuable information can be obtained quickly and cheaply, using this simple approach. Here some readers may find something very new.

Ten years have passed since the last extensive work devoted to this subject. Most of the authors appear to have completed their writing in 1974–5, but this work is essential as a source of reference in all polymer laboratories and contributes much to the general problems of characterization.

F. W. Peaker