Book Reviews

Works intended for notice in this column should be sent direct to the Book-Review Editor (J. H. Robertson, School of Chemistry, University of Leeds, Leeds LS2 9JT, England). As far as practicable books will be reviewed in a country different from that of publication.

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Macromolecular physics, Vol. 3: Crystal melting. By B. Wunderlich. Pp. xv + 363. London: Academic Press, 1980. Price £23.80, US $42.50.

Professor Wunderlich provides his own condensed description of his book in his preface in writing that he hopes this volume 'represents an attempt to reach a new level of summary of macromolecular physics on the basis of which further progress can be achieved'. This book is the third of a series on macromolecular physics. Volume 1 dealt with crystal structure, morphology and defects, while Volume 2 presented a summary on macromolecular crystal nucleation, growth and annealing. Volume 3 summarizes our present knowledge of the melting of linear, flexible macromolecules. The book is in three sections and goes from the topics of equilibrium to non-equilibrium and copolymer melting.

Section I deals with equilibrium melting and starts with the characterization of matter through its equilibrium melting behaviour. The equilibrium melting process is then presented in terms of general statements about melting and further discussed for the case of flexible linear macromolecules. The general problems of extrapolation to equilibrium data of flexible linear macromolecules are reviewed for volume and heat-capacity changes on melting, melting temperature and heat of fusion. A review on available experimental data follows. Changes in the equilibrium melting temperature as a function of molecular-weight distribution, pressure effects and diluent effects are presented and analysed. From this section it is clear that equilibrium melting of flexible linear macromolecules can give insight into the nature of molecules and phase structures.

Section II provides ways of recognizing irreversible melting. For the first time, experimental methods that can fix metastable structures long enough for investigation are reviewed. A selection of experimental information based on (*a*) crystals grown from solution, (*b*) crystals grown from the melt, (*c*) deformed crystals is presented. The final four chapters deal with some special topics: the melting at above zero-entropy production, melting temperatures occurring from superheating, the changes in the temperature of melting due to the effects of diluent or solvent; the observation of a local melting equilibrium at the surface, and the possible description of melting in single-phase systems.

Perhaps the most challenging part of this book is reached with section III where copolymer and isomer melting is treated. The first part deals with a necessary presentation of the chain structure and conformation in semi-crystalline copolymers and isomers. Next, an effort is made to discuss approximations to equilibrium melting. This incorporates attempts to describe phase diagrams mathematically as well as a discussion on some experimental approximations. Then the non-equilibrium melting of copolymers and isomeric macromolecular systems is presented following a classification in terms of random copolymers, regular copolymers and block copolymers. These sections incorporate the available experimental data. Finally, side-chain crystallization is treated as a special case of copolymer crystals.

Each section ends with references which are substantially complete through to the end of 1978. Both author and subject indexes are given at the end of the book. The book is carefully produced, fully illustrated and carefully proof-read. The author deserves the congratulations and gratitude of the polymer community for this major contribution.

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Computer processing of electron microscope images. Edited by P. W. Hawkes. Pp. vi + 296. Berlin, Heidelberg, New York: Springer-Verlag, 1980. Price DM 65.00, US $36.40.

This book is written by well known scientists, who are closely concerned with the actual problems of modern electron microscopy.

The subject of the first chapter (Hawkes) is the relationship between bright-field image and complex specimen transparency, and various techniques for exploiting it. Transfer functions for coherent and partially coherent illumination are introduced and described at a high mathematical level; numerous examples are given. Practical applications of the linear relationship are realized as: firstly, a straightforward method of establishing the microscope operating characteristics (C_s) and (Δ); secondly, setting the objective stigmator correctly in the case when the microscope image can be on-line controlled by computer; and thirdly (the most interesting), filtering members of a focal series to reconstruct phase and amplitude images with the best possible elimination of the deleterious effect of C_s and Δ.

The second chapter (Saxton: *Recovery of specimen information for strongly scattering objects*) is devoted to the problem of image correction for stronger objects, when the imaging process is non-linear. Two approaches are put forward: the first is based on an iterative application of the linear theory; the second is connected with twin intensity measurements. The theory is devoted to 'analytic' images, based on the constraint of a finite diffraction plane aperture. 'Holographic' methods dependent on the addition or removal of a reference beam are considered as well as 'ptychographic' methods in which neighbouring diffraction beams are made to overlap in such a way as to reveal their relative phases. A new non-iterative method is proposed, based on a bright–dark field subtraction, that allows a proper treatment of the coherence conditions.

In chapter 3 (Mellema) the basic theory of image processing in the field of biological structure is presented, and the type of biological object amenable to this approach is discussed. Two cases can be distinguished. In one case, two-dimensional information about the specimen is derived; in the other, a three-dimensional reconstruction of the object is carried out from its two-dimensional projection. Some crucial questions concerning the state of the object in the microscope, the effects of radiation damage and the type of information recorded on the micrograph are discussed as well.

Chapter 4 (Hoppe & Hegerl) is devoted to the study of the three-dimensional structure of non-periodic systems by electron microscopy, when the crystal degenerates to a single unit cell filled with the finite object. Although no crystallization is necessary, the same Fourier transformation on a number of discrete structure factors leads to the reconstructed object. The problem of interpolation owing to experimental restrictions should be stressed. The authors remind us of already well known methods and propose new ones, based on axial and conical tilting. As one of the promising aspects for the future, Hoppe proposes the use of the 'atom' constraint for the correction of the phases derived from electron microscopy and consequently the refinement of the structure, as well as the use of the STEM as a diffractometer.

Chapter 5 (Frank) is concerned with the statistical analysis of images in real space by correlation functions. The method of computer image processing by correlation techniques is presented (autocorrelation and cross-correlation functions), which is of importance for the analysis of electron microscope images. Apart from direct applications of correlation techniques for structure determination, the assessment of instrument performance in terms of its resolution and signal-to-noise ratio can be accomplished with the correlation function. The author concludes that even though the computer cannot compete with optical correlations for speed and simplicity of operation, its accuracy and flexibility make it superior.

The two-stage imaging process, common to all holographic procedures, is considered in chapter 6 (Wade). The essential *unity* of different types of holography is shown *via* the zone-plate representation. A review of electron holography experiments from the early 1950's onwards is given in some detail. The in-line and the single-sideband techniques are considered as the best.

The authors of chapter 7 (Isaacson, Utlaut & Kopf) discuss the use of electronic techniques for functional manipulation in conjunction with STEM. Instead of giving electronic circuitry in detail, they prefer to discuss the technique in terms amenable to block-diagram descriptions. The usefulness of colour conversion of black-and-white intensity levels, to extract the maximum information from the image, is shown.

In conclusion, I should remark that this book will be extremely valuable for anyone using electron microscopy methods.

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Liquid crystals: the fourth state of matter. Edited by F. D. Saeva. Pp. x + 491. New York: Dekker, 1979. Price, SFr 106.00, £33.40.

It is fair to say that, without the great ingenuity of chemists in the last twenty years, the physics of liquid crystals would have remained some kind of laboratory curiosity. Liquid-crystal research has been and still is (and will continue to be) a true interdisciplinary subject.

During the past two decades probably more than 1000 new compounds displaying liquid-crystal behavior have been discovered, new liquid-crystal symmetries brought to light, relationships between molecular structure and mesomorphic behavior established; lyotropic and polymeric systems, whose occasional or generic LC behavior was initially not very much more than a curiosity, are now more numerous than thermotropic compounds were in G. Friedel's or F. Grandjean's time (in the early twenties). The relationships between molecular structure and physical properties are attracting more than ever the attention of physicists, with the discovery of new symmetries, the interest in two-dimensional systems, the progress in our theoretical understanding of phase transitions. Last, but not least, the extraordinary success of LC in display systems (watches, flat pocket computers, *etc.*), and their probable use in the near future in TV screens, appeals for a better understanding of the fundamental processes at a microscopic level, and for some kind of liquid-crystal 'engineering' (to use R. B. Meyer's terminology).

Experimental research has been very active but new fundamentals have not clearly emerged which would bring clarity to this difficult problem of the relationship between structure and mesomorphic behavior. In such a situation, a book like the present one edited by Dr F. D. Saeva might be the right answer. According to his preface, it is also an introduction to LC research; *i.e.* some chapters of general interest are included. It is my purpose in this review to describe these various contributions, and to show that the objective has been only partially reached.

This book starts with a very long chapter by A. de Vries (Kent State University) devoted to the structure and classification of thermotropic liquid crystals. There is here a very complete account of various results obtained either by X-ray diffraction, or by miscibility studies. The author insists very much on smectics, for which he proposes a classification which might be contested, but which is introduced with clarity and provides the opportunity of a thorough discussion of various factors, mostly geometric, at the basis of this structural classification (parallelism, layer formation, molecular translation, generality of herringbone packing, influence of the presence or absence of cybotactic groups, *etc.*). This is in summary an excellent and stimulating review article for the senior research worker, probably not an easy introduction for the newcomer. Since this chapter was written in 1976 (like most of this book) an addendum was added recently, which takes stock of recent advances. However, nothing is said about the discotic mesophases.

The three following chapters deal with the classical nematic (by F. D. Saeva, Xerox Corporation), cholesteric (by H. W. Gibson, Xerox Corporation) and smectic (by S. E. B. Petrie, Eastman Kodak Company) mesophases. Saeva's