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

discussion of molecular structure effects in benzylidene anilines, esters and carbonates, and cyanobiphenyl derivatives, is presented with a lot of useful references. Gibson's big article on cholesterics (174 references) insists on a description of molecular structural effects of steroidal compounds (cholesteryl derivatives and others), less on those of chiral nematic compounds. A large number of results seem to be reviewed here, but one realizes that there is not yet any real understanding of the relationship between molecular structure and mesomorphic character, still less of the chiralization process of the crystal structure. The largest part of Petrie's paper deals with the same subject as de Vrie's paper with some stress on thermodynamic data compared to miscibility data. Molecular structural properties are quickly discussed, unfortunately, although one knows that considerable work, both theoretical and experimental, has been done in this field recently. On the other hand, Petrie's article contains a table of characteristics of thermotropic liquid crystals (nematic and cholesteric included) which mentions *textures* without discussing them in detail. I will come back to this point later on.

Chapter 5, by D. B. Du Pré (Louisville) and E. T. Samulski (Connecticut), is a very welcome review of the physical properties of PBLG (poly-γ-benzyl-L-glutamate), a synthetic polypeptide which is today one of the best characterized macromolecular lyotropic liquid crystals, ordering in right or left cholesteric phases, or in nematic phases, according to the solvent. The macromolecule itself is an α-helix, and the origin of the chirality in solution is an open problem, although some interesting models are given, which might have some relevance to the general problem of thermotropic cholesterics.

Cholesteric liquid crystals seem to be a favorite subject at Xerox Corporation; Chapter 6 (by Saeva again) deals with liquid cholesteric crystal induced circular dichroïsm (LCICD) and Chapter 7 (by J. M. Pochan) with the structural interpretation of the rheo-optic properties of the cholesteric mesophase. Numerous experimental results in LCICD indicate the relationship with molecular optical processes, spectroscopic and conformational effects, *etc.* I can believe with Saeva that LCICD has a future for the characterization of cholesteric liquid crystals. I am also convinced by Pochan's exposition of rheo-optics that it is an important topic, but would have liked, in such a difficult subject, the importance of textures, defects and instabilities to be more clearly stated. I am persuaded that any advance in the rheology of LC requires deep understanding of the role of defects.

Chapter 8, by D. Chapman (University of London), is a review on liquid crystals and biological membranes. Except for one, few references are very new, but such a chapter was a necessity in such a book, although the subject has not developed very much recently; it is a clear and readable account, which might be useful to any newcomer. There are, however, some regretable omissions like that of the work of Helfrich and his collaborators on vesicles and lecithin textures.

E. M. Barral II (IBM, San Jose) gives in Chapter 9 a number of thermodynamic data concerning mesophases, with a bibliography. It can be considered as an introduction to the use of complete tables, whose publication is still awaited.

Chapter 10, by B. J. Bulkin (City University of New York), is devoted to infrared and Raman spectroscopy of liquid crystals. This is a welcome review of a subject which has not attracted much attention up to now but should do so in the future, if attention is focused on intermolecular forces. However, interpretations seem still to pertain to the domain of discussion between experts.

Chapter 11, by J. M. Pochan *et al.* (Xerox), is more like an original contribution than a review article: it deals with the various phases of a poly(diethyl siloxane), a polymer which has a quite low glassy transition ($T_g \sim 140$ K), and one of whose crystalline phases melts near 270 K towards a so-called 'viscous crystalline' phase, which the authors suspect to be a liquid crystal.

Finally, Chapter 12 constitutes a very short introduction to the applications of liquid crystals, by J. A. Castellano (Princeton Materials Science).

As it is, this book is not unuseful, but it could have been more valuable if the perspective in which it has been edited had been more clear-cut: it is, apart from four chapters, very markedly on the applications side, and it is in this perspective that there is so much insistence on the relationship between molecular structure and mesogenesis. Since this is one of the most unrationalized parts of the physics of liquid crystals, it is not very surprising that very often the text appears like a list of results or recipes. This will make the reading of some chapters quite difficult for the newcomer. I also regret the absence of any chapter on NMR methods, which would have been in their right place in this book.

I am also persuaded that applied LC physics must also be grounded on a good knowledge of the physics of textures, defects and instabilities, whose understanding is so important in display systems and rheological properties. This is also absent from this book, or presented as trivial knowledge, which is wrong.

Finally, I regret that this book appears such a long time after the writing of the various chapters. For a book which is not devoted to fundamentals, four years is too long a delay, and a part of it is already out of date.

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