Book Review

Molecular Electro-Optics Part 2. Application to Biopolymers

Edited by C. T. O'Konski

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This volume is the second, and one hopes not the last, in a series on molecular electro-optics. Molecular electro-optics essentially involves monitoring the electrical orientation or deformation of molecules of a fluid, by observing the consequent macroscopic changes in the optical properties of the fluid. Measurements of the rate and magnitude of the imposed changes provide a powerful technique for characterizing macromolecules. Original research papers are published in a variety of journals of diverse disciplines. Review articles are scarce and are often confined to particular methods or applications. Thus this series of books describing the methods, theory and applications is timely and welcome. The series is edited by Professor O'Konski – one of the founder fathers of this area of science. The first volume (Part 1) describes the various experimental methods available and the present volume (Part 2) enhances the first by outlining applications to biopolymer systems. Each chapter is written by eminent workers in their fields and, as expected, the chapters are comprehensive and enthusiastic reviews of the selected topics. Besides emphasising the potential of the methods, the authors openly describe difficulties encountered in measurement or interpretation and signpost areas of future exploration. In this respect it is unfortunate that there are few references later than 1972, although clearly this is an inherent problem in compiling a text composed by numerous authors from many lands.

In reading this volume I was reminded of biting into a sandwich. The first two chapters combine well and deal with collection and interpretation of relaxation data. The last two chapters form a pair which review data on exotic concentrated systems. For me the meat of the text lay in the middle four chapters, describing applications of the methods to a variety of dilute suspensions of macromolecules and complex macromolecular assemblages.

To study rates of orientation it is convenient to apply pulsed electric fields and observe the transient changes in optical properties. For studies on biopolymers suspended in conducting media such methods are essential. The first chapter (chapter 15) deals with methods of recording the optical transients and analysing the field-free decay to obtain rotary diffusion coefficients (D_R). Analytical techniques reviewed range from simple graphical methods, through the use of analogue simulation to computer analysis. The chapter concludes with a description of an on-line apparatus for data collection and analysis. chapter 16 reviews methods of interpreting D_R in terms of particle dimensions and solvation, by the combined use of electro-optic and other hydrodynamic data. The procedures are critically assessed and illustrated by experimental results. Such detailed analysis has already led to the modification of at least one hydrodynamic equation. Both chapters are hard going for non-experts It is thus a pity that in the remainder of the book it is not clear to what extent such elaborate interpretation has been applied to the practical systems studied.

The following four chapters are very rewarding. Chapter 17 describes the use of various electro-optic methods to study synthetic polypeptides and proteins. The wealth of data is assembled and presented in an easily readable fashion. For polypeptides one is shown how the methods permit studies of molecular conformation, helix-coil transitions and molecular clustering. The sections on the aggregation or polymerization of fibrous proteins is particularly fascinating in view of the biochemical and medical applications, as are the sections on the aggregation and sub-unit structures of globular proteins. In this chapter one encounters 'anomalous transient' behaviour and models for their interpretation. Chapter 18 is devoted to the ribonucleic acids and polynucleotides. One sees how electro-optics can be used to deduce conformation, to study binding of small ions, as well as characterising the macromolecules electrically nad optically. Questions are raised about the non-'Kerr-like' behaviour of DNA and other polyelectrolytes. Here one encounters the controversy over the existence of a permanent dipole moment for DNA, and the origin of the anisotropy of the electrical polarisability ($\Delta\alpha$). The use of electrical birefringence as an analytic tool for chemical kinetic studies is mentioned. Chapter 19 is concerned with polyelectrolytes in general and dye-polyelectrolyte complexes. The idea that the predominant contribution to $\Delta\alpha$ for such systems arises due to polarisation of the double layer structure surrounding the molecules is introduced. The pioneering theoretical work of O'Konski and co-workers is described and experimental data on numerous polyelectrolyte systems reviewed. I was disappointed by the absence of discussions of the more recent theoretical work on the polarisation of bound counterions and the theoretical studies of Dukhin and co-workers. Perhpas these will be discussed in a later volume. The section on dye–polyelectrolyte complexes illustrates the ability to determine the orientation of the dyes within macromolecules. Chapter 20 deals with the electro-optics of molecular assemblages such as viruses, nucleoproteins and ribosomes. The studies on the packing of DNA within the head of bacteriophages and the conformation of the tail fibres of T-even bacteriophages are particularly intriguing.

The final two chapters stand somewhat apart in dealing with the electro-optic effects observed in concentrated systems such as nerve membranes (chapter 21) and liquid crystals (chapter 22). In chapter 21 one is shown, from the review of the measurements made to date, the potential of the techniques but one is adequately warned about the difficulties of measurement and interpretation. Chapter 22 introduces the numerous and fascinating electro-optic effects observed in liquid crystal systems. The general impression conveyed, is that the simplicity of the systems studied and the measurements made are more than offset by the difficulties encountered in the interpretation, due mainly to the complex electro-hydrodynamic processes involved.

This volume, and its companion in the series, provide an invaluable collection of review articles for those actively engaged in, or interested in applying molecular electro-optical techniques to study specific experimental system. I hope the series will be extended and look forward to the possible appearance of Part 3.

V. J. Morris