

## Liquid crystals

**Liquid Crystals: Applications and Uses**, vol. 1. Birendra Bahadur, ed. World Scientific, Singapore, 1990.

Liquid crystal (LC) technology is becoming increasingly prominent owing to the intensive development that has occurred over the last twenty years. The field can be broadly split into two areas: electro-optic devices, in particular liquid-crystal displays such as those used in watches and calculators, which are becoming a serious rival to the cathode-ray tube; and liquid-crystal polymers, which can be used to make fibres with high tensile strength.

Volume 1 of *Liquid Crystals: Applications and Uses* deals with the former of these topics. It covers both the theoretical background and the applications of the various subclasses of thermotropic LCs. There are several authoritative books about the fundamental operation of liquid crystals, but there is no recent book (to my knowledge) that deals with LC applications aimed at the engineer or the applied scientist. The foreword begins with 'This three-volume set provides a much-needed comprehensive treatise on the important technology of liquid crystals with a focus on applications'.

I shall outline the book chapter by chapter. (The incomplete numbering is because some of the chapters are contained in volume 3.) Chapter 1 (D. Demus) gives an account of the different liquid crystal phases. It describes both *thermotropic and lyotropic* LCs. The chapter is basically a factual list of the different LC structures and so as an introduction I felt this article is lacking in general discussion on exactly why liquid crystal materials are interesting and how they can be used.

Chapter 2 (N. V. Madhusudana) outlines the different theories of LCs based on hard rod, curvature elasticity and mean field theories. It covers nematic, cholesteric and smectic phases. This is an interesting overview of the theoretical understanding for those who wish to bypass the more in depth books.

Chapter 3 (D. Coates) describes the chemical structure of LCs. It explains how the intramolecular groups affect the

attributes of the material and how this structure can be engineered to optimize different physical properties, for example birefringence or viscosity.

Chapter 4 (L. Pohl and U. Finkelzeller) discusses physical properties, such as anisotropy, optical and magnetic properties, and elastic properties. It also considers the effect of molecular structure upon these properties.

Chapter 7 (S. Morozumi) is about the practical aspects of the construction of twisted and supertwisted nematic displays. It covers materials such as glass substrates, electrodes, polarizers and spacers as well as the assembly of these components. This is an interesting and unusual chapter about a subject that is easily overlooked by workers not directly involved with manufacturing.

Chapter 9 (B. Bahadur) reviews the dynamic scattering mode of operation. This was the first method used to utilize the electro-optical properties of LCs to produce display devices. The chapter covers both the theoretical background and the practical application of the dynamic scattering mode. This article is mainly of historical interest since this mode of operation is now obsolete.

Chapter 10 (T. Scheffer and J. Nehring) covers the basics and applications of the twisted and supertwisted nematic displays. These are the most commonly used modes of operation, and so this chapter is probably the one that holds the most interest for the applied scientist. It is well written and contains a lot of application relevant material, for example contrast ratios, viewing angles, grey scales and colour.

Chapter 12 (D. Coates) discusses laser, thermal and electrical addressing techniques of the smectic A phase which exhibits a memory effect. It also considers the newer and potentially interesting electroclinic effect, whereby the LC director angle is continuously controllable at fast switching speeds.

Chapter 13 (J. Dijon) considers ferroelectric LCs which are a promising display material owing to their fast response time. This review covers structure and materials, alignment and addressing techniques. Ferroelectric LCs are essentially bistable devices but this article also describes how they may be used for grey scale and colour generation.

Chapter 14 (J. W. Doane) is about polymer dispersed liquid crystal displays. These LCs can be used to make very-

large area devices that can be used, for example, as switchable windows. The articles cover the application relevant parameters such as voltage response, response times, contrast, device types and stability.

Chapter 15 (F. C. Luo) describes the technique used to control a large array of LC elements, called active matrix addressing, by incorporating electrical circuit elements into a display to control the switching of individual elements. This article considers both the use of diode and thin-film transistor technology.

Chapter 16 (S. E. Shields and W. P. Bleha) covers LC light valves with reference to their use in projection systems. Comparisons are made between the different systems and there is a good natural progression of ideas. There is no discussion of light valves for non-display applications. Indeed the whole volume only considers display applications. There is, however, a chapter in volume 3 about optical computing, an area of increasing interest.

Chapter 18 (P. Palfy-Muhoray) reviews the nonlinear optical properties of LCs. Liquid crystals exhibit large nonlinear effects and so they are a suitable material in which to study these effects, which this article describes. However, the applications are relegated to a short section at the end of the chapter. Bearing in mind that this book is aimed at scientists with a broad range of expertise, this chapter suffers from a poor introduction (a very common complaint in the scientific literature), which could make it somewhat intractable.

The book covers a broad range of topics written by some of the field's authoritative researchers. It contains a large amount of information and so is useful as a reference manual for liquid-crystal scientists. However, it must be borne in mind that LCs are a rapidly developing field, and so the most recent developments are not included in the book.

My criticism of the book arises because it is little more than a collection of review articles. Each chapter is a separate piece of work so, as a whole, the book lacks coherence. The book's useful relevance to an applied scientist who is not directly working with LCs, but who wishes to utilize them for some application, is limited. For example, if response time is an important factor one

would have to search through a lot of information spread among different chapters to find the relevant details. In my opinion, what is needed is a book that explains, compares and summarizes the different techniques of using LCs in a way that is accessible to those outside the field, and yet contains enough information to be more than just a general article.

This review is written from the perspective of an applied optical scientist working with LCs. For a review from an alternative viewpoint see M. Schadt, *Condensed Matter News*, 1992, 1(3), 25.

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## Phase transitions

**The Many Phases of Matter.** G. Venkataraman. Orient Longman Ltd., 3-6-272, Himayat Nagar, Hyderabad 500 029 1991. 94 pp. Rs 30.

The book under review is written in the same spirit as George Gamow's famous volumes which inspired the author. The book is aimed at young students who wish to take up later a serious study of physics. It is intended as a bridge to the more serious textbooks such as the *Feynman Lectures* and the Landau-Lifshitz classics. The author has adopted a simple, chatty style to convey the excitement of science. In his words 'if the reader is able to experience at least in some small measure the excitement of science, then my purpose would have been served'.

The book is about phase transitions. It starts out by defining what a phase is and goes on to discuss the variety of phases of matter that are observed in nature, order and disorder, quasicrystals, fluctuations and symmetry breaking, critical phenomena and exponents, mean field theory, superfluidity, superconductivity, phase transitions and life, as well as phase transitions in the early universe. And all this in 94 pages.

Although the reviewers are by no

means any longer young, they found the book very instructive and a convenient digest of the entire gamut of phase transitions. Each chapter is compact, well illustrated by helpful diagrams, and contains boxes with interesting information about the leading physicists whose work figures in it, as well as auxiliary information relevant to the chapter. Each chapter also contains a useful summary at the end.

Quite consciously the author has pitched things a bit high on occasions, as, for example, in the case of the Landau theory, where he introduces the concept of the order parameter and elements of bifurcation and catastrophe theory. To what extent this sort of high pitch will 'excite' the young readers rather than discourage them is perhaps a debatable point, particularly in our country where school education in science is woefully inadequate.

We found the treatment of superconductivity too brief compared to the treatment of superfluidity. For example, a few more words to explain how Cooper pairs are formed would have made this section less mysterious. We are also surprised that no mention is made anywhere of the role of Bose statistics and Bose condensation in these phenomena. This would have been particularly relevant in the Indian context.

The chapter on phase transitions and life is obviously intended to give a mere flavour of this extremely difficult and challenging area. It discusses nonequilibrium phase transitions, bifurcations, convection patterns, symmetry breaking aspects and the origin of life. We did not find any mention of the pioneering work of Prigogine and his group on nonequilibrium thermodynamics and the fundamental role of dissipation in the formation of new structures ('dissipative structures'). This is essential in understanding how order can emerge out of chaos in nonequilibrium situations despite the reign of the second law of thermodynamics.

The last chapter on phase transitions in the early universe is also written in a similar vein and serves as a good introduction. However, there is one statement regarding the weak force that we find misleading. It says that this force was 'explained to us by E. C. G. Sudarshan, and also by Gell-Mann and Feynman'. The Sudarshan-Marshak-

Gell-Mann-Feynman V-A theory is not really an 'explanation' of the weak force but only a characterization. The 'explanation' in terms of more fundamental fields came later with the Salam-Weinberg-Glashow theory.

The above minor criticisms in no way detract from the importance and value of the book. To the best of our knowledge, this is the first book of its kind written by an Indian author for Indian students. The publishers deserve to be congratulated for bringing out this first book in a series entitled 'Vignettes in physics' by Venkataraman, a well-known physicist whose recent book *Journey into Light: Life and Sciences of C. V. Raman* has been widely acclaimed. There is every reason to look forward to reading the forthcoming volumes, which include *Why Are Things the Way They Are?*, *Chandrasekhar and His Limit*, *Bose and His Statistics*, *At the Speed of Light* and *Raman and His Effect*.

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## Brief reviews

**A Course of Experiments with He-Ne Laser.** R. S. Sirohi. Wiley Eastern Ltd., 4835/24, Ansari Road, Daryaganj, New Delhi 110 012. 1991. 106 pp. Rs 45.

As the name suggests, the book contains a large number of experiments that can be performed using a low-power He-Ne laser. These experiments deal with concepts of interference, diffraction, polarization, holography, speckle phenomena, spatial filtering and laser Doppler anemometry. The experiments cover both undergraduate and graduate level laboratory course. Although some of the experiments described can be done by quasi-monochromatic light (e.g. sodium lamp), the use of He-Ne laser makes them much more appreciated by the students. To quote the author: 'What seems to be difficult to observe with