

Chromic Phenomena. Technological Applications of Colour Chemistry

Peter Bamfield, Royal Society of Chemistry, Cambridge, 2001, xx + 374 pp., price £59.50, ISBN 0-85404-474-4

This is an excellent book, and if the slightly enigmatic title encourages one to enquire within, one is not likely to be disappointed. A perusal of the contents list reveals that this book is something special, and is a text that fills an obvious gap in the literature of modern colour chemistry. This is not just another book on the technology of dyes and pigments, and in the author's own words, the book aims to provide "an overview of the many applications that colour chemistry, in its widest sense, has found in the last couple of decades". As might be expected from an author with such wide experience in the relevant industries, this is achieved in a most comprehensive and readable way. The coverage is extensive, dealing with advances in both aesthetic and purely functional applications of colorants. In addition, and rare in any book on colour chemistry, colour generation by physical effects (interference, scattering, *etc.*) is given full consideration alongside more conventional "chemical" sources of colour, *i.e.* colour involving electronic transitions.

The term "chromic phenomena" is an interesting one, and one that is difficult to define precisely. The implication, of course, is that these are colour related processes. In this book, most, but not all, of the described phenomena involve the response of a chromophore to an external stimulus, as in, for example, photochromism and electroluminescence. However, sometimes such processes may not relate to colour at all, as in the use of colourless near-infrared dyes for optical data storage materials and in security printing. The term is also used by the author to describe phenomena involving the physical manipulation of light, and again such processes may be encountered where colour is absent. Clearly, the word "chromic" should therefore be interpreted liberally, and need not be restricted solely to applications involving colour. In this respect, it is surprising that there appears to be no reference in the text to the terms "functional dye", or "functional π -system", as these descriptors are in common parlance, and do help to differentiate passive aesthetic colorants from active colorants whose application is totally independent of colour.

The author classifies the very wide range of technological applications dealt with in the book according to five distinct types of chromic phenomenon. These classes form the basis of the five principal chapters of the book. A minor criticism can be levelled at the phrasing of some of the chapter headings, as on first reading they can be a little ambiguous. For example, chapter 3, entitled "Phenomena involving absorption of energy and emission of light", needs to be read as "Phenomena involving absorption of energy *followed by* emission of light". Similar ambiguities arise with the titles for chapters 2 and 4. However, if one reads and digests the opening introductory chapter before dipping into this book, the meanings of these titles are made clear, and the reader will have no difficulty following the logic of the text. Although certain applications might be considered to fall into more than one of these five groups, the author's scheme generally works well, and he is to be com-

mended for neatly resolving this extremely complex and multi-disciplinary field into just five discrete types of phenomena.

The first chapter deals with reversible colour change systems, and includes such effects as photochromism, thermochromism, ionochromism and several other "chromisms". In contrast, the second chapter deals with permanent subtractive colour, and covers, for example, recent developments in conventional colorants, and the newer technologies of ink jet printing and electrophotography. Chapter 3 is concerned with light emission processes initiated by the absorption of energy. Thus the phenomena of phosphorescence, fluorescence, chemiluminescence and electroluminescence are discussed, with many examples provided of their technical application. The basic premise of the chromic phenomena discussed in chapter 4 is similar to that in chapter 3, namely stimulation of a molecule by light absorption, but in this case the resultant electronic excitation energy is utilised in secondary processes other than light emission, such as generation of thermal or electrical energy. Materials which fall into this category include organic photoconductors, photosensitizers, and colorants used in photovoltaic devices and optical data storage systems. The last chapter considers phenomena involving manipulation of light, rather than light absorption by electronic excitation. This leads to such topics as holography and non-linear optical materials, and applications based on the polarisation of light (*e.g.* liquid crystal devices), and interference and diffraction phenomena (*e.g.* lustre and colour variable pigments).

Give the immense scope of the subject area, one cannot expect any of the major topics to be dealt with in great depth, but nevertheless the information provided is sufficiently detailed for most purposes, and there are few omissions of any significance. In all the topics discussed, relevant background material is provided, and the commercial applications are highlighted. The book is well referenced, with a good bibliography. Although the main purpose of the book is to review recent technological developments, there is an adequate amount of introductory material to help the uninitiated. For example, the bulk of chapter 2 deals with the basic chemistry of the more important organic and inorganic colorant classes, and also gives a brief introduction to colour physics.

This is a well thought out and very well written book, which will prove indispensable to anyone with an interest in high-technology colorants or functional applications of π -electronic materials. In addition it is to be strongly recommended to students who wish to familiarise themselves with the most recent developments in colour chemistry.

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Medicinal Natural Products—A Biosynthetic Approach

P. M. Dewick, Wiley, Chichester, 2nd edition, 2000, xii + 507 pp., price: paperback \$55 (£34.95), hardback \$115, ISBN 0-471-49641-3

You can be sure that a scientific monograph has been successful when it appears in a new edition; it is sales which justify this updated publication. Commendably and most usefully this

second edition of Dewick's compendious book is right up to date with references up to and including 2001 in some cases. The very latest material appears here. This includes the exciting deoxyxylulose phosphate biosynthetic pathway to isopentenyl pyrophosphate (IPP) and hence terpenes that was discovered recently, which is an alternative to "traditional" biosynthesis *via* acetate-mevalonate and IPP.

The monograph "has been written primarily for pharmacy undergraduates to provide a modern text to complement lecture courses dealing with pharmacognosy [defined as the knowledge of drugs] and the use of natural products [secondary metabolites] in medicine". Its 507 pages are packed with information on natural products as drugs and on biosynthetic pathways. These pathways are seen to provide links between different secondary metabolites of sometimes apparently unrelated structure and to give a coherence to the material presented.

I was somewhat overwhelmed by the amount of information in the book. Everything seems to have been included and I would have valued selection, especially for undergraduates. The book reaches well beyond post-graduates. On the other hand, the index is excellent. I could not fault it as a means for finding material. It is clear to me that this is a reference book, hardly bedtime reading.

They say that in general one reads more obituaries as one gets older. It may be that ageing chemists look up the structures and properties of the drugs they are forced to take. I found the information on natural product drugs concise and immediately accessible. But I did not like the way the material was presented in (shaded) boxes in the running text. The text is then fragmented and often difficult to read. Overall I consider that the presentation of material is poor; the structures are small and multitudinous, the Schemes are often cluttered. Further I would have preferred time-tested formulae numbers rather than embracing "figures". The quality of the material deserves better presentation.

It is inevitable that a new edition involves some cobbling together of old and new material. Generally this is not noticeable but it is when we come in the book to the most important current work on polyketides. Erythromycin appears twice, the second time being the latest work by the Cambridge group of Leadlay and Staunton which appears in a final section ("Genetic manipulation of the acetate pathway"). Though at least one Cambridge diagram is used, acknowledgement of the work of this group fails to appear in the relevant list of references (or "Further Reading"). This is an unfortunate and serious oversight. The reviews by Rawlings which head up the Further Reading provide, however, access to this work. The latest is in *Nat. Prod. Rep.*, 2001, **18**, 231. There are additionally other accounts, e.g. James Staunton and Barrie Wilkinson, Biosynthesis of erythromycin and related macrolides. *Comprehensive Natural Products Chemistry, Volume 1. Polyketides and other Secondary Metabolites including Fatty Acids and their Derivatives*, U. Sankawa, D. H. R. Barton, K. Nakanishi, O. Meth-Cohn (eds), Elsevier, Oxford, 1999, pp. 495–532.

Otherwise the selected references work well. I was delighted to see the latest work done on colchicine biosynthesis and partly in Leeds presented but sadly the reference quoted was 1992 when the work was published in 1998.

The chapter titles are as follows: about this book and how to use it; secondary metabolism: the building blocks and construction mechanisms; the acetate pathway: fatty acids and polyketides; the shikimate pathway: aromatic amino acids and phenylpropanoids; the mevalonate and deoxyxylulose phosphate pathways: terpenoids and steroids; alkaloids; peptides, proteins, and other amino acid derivatives; carbohydrates.

A defining test for a monograph is whether it continues to be consulted. I shall certainly use this text and I shall value it for the many biosynthetic pathways and the information on the biological properties of natural products. But I shall be

working through the index. May this edition be as successful as the first.

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Anisotropic Organic Materials—Approaches to Polar Order

Ed. R. Glaser and P. Kaszynski, Oxford University Press, USA, xiii + 322 pp., price £85, ISBN 0-8412-3689-5

In 1974 the American Chemical Society launched the *ACS Symposium Series* in order to facilitate the rapid publication of various symposia. The book under review here is number 798 in the series, and contains 21 papers that were presented at the International Symposium on Anisotropic Organic Materials, which was part of the 218th National Meeting of the American Chemical Society held in August 1999 at New Orleans.

The book is principally concerned with the design, synthesis, properties and applications of organic materials. Relatively recent high intensity research in the area of polar organic materials has been driven by the vast array of potential high technology applications, with the following words and phrases springing to mind; liquid crystals for displays, light emitting organic materials, wide band gap materials, high photoluminescence, electrochemical materials, organic transistors, semiconductors, molecular wires, sensors, solar cells, non-linear optics, optical devices for telecommunications, *etc.* However, there is also much research being carried out of a more fundamental nature in order to increase our understanding of structure–property relationships in polar organic materials. Such properties include a wide range of optical effects, electrical conductivity, thermal conductivity, ferroelectricity, *etc.*, all of which depend critically on molecular anisotropy and polarity.

The 21 papers are contained in 5 sections: (1) Characterization of Polar Materials, (2) Organic Thin Films, (3) Molecular Materials and Crystals, (4) Liquid and Crystals, and (5) Liquid Crystals. Not all the sections are equally represented, since Liquid Crystals generates 9 papers and Molecular Materials and Crystals just 6 papers, with the remaining 6 papers split equally between the other 3 sections.

As a collection of conference papers the book is not a coherent, progressive read. However, each paper is, of course, self-contained and can be read separately, which is just as well because some of the papers make heavy reading. As a synthetic organic chemist in the research area of liquid crystals, I was obviously familiar with the research of the papers in the Liquid Crystals section and I enjoyed reading them, and to some extent learning from them. However, most aspects have been published previously in one form or another, probably in part due to the fact that the conference took place nearly 3 years ago. Certainly, the book has much to interest those working in areas of materials synthesis, evaluation and applications, and may make for interesting peripheral reading for many readers of *Perkin Transactions 1*. However, anyone expecting this book to be heavily focused on organic materials will be a little disappointed; the book hardly gets off to a good start with the first two papers containing just a solitary organic structure! The situation remains little changed with the focus of the papers very much on the theoretical, physical and engineering aspects of materials. However, there is an element of interest for the organic chemist in finding out just what organic materials are capable of in terms of their physical properties and potential applications.

The first paper to really catch my eye was that on boron *closo* clusters, which are inorganic ring systems regarded as 3-dimensional σ -aromatic compounds. These fascinating systems have a barrel-shaped molecular geometry, which makes them well suited for incorporation into liquid crystal structures. The paper is very pictorial and provides excellent detail of

molecular dimensions and symmetry of the boranes and gives comparison with benzene. The electronic properties are discussed in relation to potential non-linear optics applications.

Thankfully, for the chemists, the papers in the Liquid Crystals section contain a great wealth and wide variety of organic structures, and a few of the papers actually include some informative synthetic schemes. The section begins with an excellent review of highly fluorinated liquid crystals in terms of design and properties. Next is a paper consisting of a substantial number of liquid crystals of ground-breaking architecture; these are nematic materials of negative birefringence, the negative birefringence being achieved by laterally linking 2 low birefringence core units with 1, 2, 3 or 4 acetylene units. The reduced symmetry of the chiral smectic C phase is of great technological importance in ferroelectric displays and light shutters and in non-linear optical applications, and chirality is the topic of a few of the chapters in this section. In particular, a paper on the role of molecular architecture and optical purity on the spontaneous polarization in ferroelectric liquid crystals discusses the molecular design features of chiral smectic C materials in relation to their properties. Another very interesting paper is concerned with the optical switching of a ferroelectric liquid crystal spatial light modulator using chiral thioindigo dopants. Banana-shaped liquid crystals are currently the subject of much research because many such materials generate liquid crystal phases with distinct reduced symmetry domains, despite being composed of achiral molecules. Such a phenomenon is often seen in the world of crystals, with a good

example being the classic spontaneous breaking of achiral symmetry in 'racemic' sodium ammonium tartrate, first carried out by Pasteur in 1849. The spontaneous symmetry breaking phenomenon of liquid crystals is a fascinating discovery that is still in the early stages of fundamental research.

I would have liked to have seen more emphasis on organic chemistry, particularly in terms of molecular design and synthesis and structure–property relationships, but obviously the content of such a book is dictated by the conference papers that were submitted for inclusion. However, the book is certainly successful in bringing together many papers that cover such a wide variety of topics from several scientific disciplines. The papers are all excellent in their scientific quality, they are all well referenced and make an excellent read for those wanting to learn more. There is an excellent index which covers all the papers, so it is very easy to find topics, and importantly to see which aspects of research are common to the various papers.

Unfortunately for most chemists, particularly the synthetic organic chemists, and probably most readers of *Perkin Transactions 1*, most of the papers are on a 'different wavelength'. This 'out of phase' incompatibility is well illustrated by the use of the acronym DAST, which to a synthetic organic chemist would mean (diethylamino)sulfur trifluoride, but to the authors of a paper on the applications of microcrystals, the acronym means 4'-dimethylamino-*N*-methylstilbazolium toluene-*p*-sulfonate.

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