book reviews

Applied Photochromic Polymer Systems

C. B. McArdle (Ed.)
Blackie & Son Ltd, Glasgow, 1991, 255 pages, £65.00
ISBN 0-216-93140-1

Photochromic compounds are able to change their colour, or more generally their absorption spectra, depending on whether they are exposed to light or dark conditions. The development of photochromic polymers and the large amount of experimental results which have appeared over the last two decades show, however, that photochromism can be of interest in connection with phenomena other than merely colour change. Photochromic polymers, in fact, are able to respond to light giving photoinduced variations of their properties, so they may be highly promising materials for application in optical technology, as well as in development of devices which can be photomodulated.

The purpose of this book is to review photochromic polymer systems from the perspective of their potential application, on the basis of literature published in the last twenty years, so its appearance is well-timed.

The text consists of six chapters written in the form of review articles. Chapter 1, by McArdle, reviews the possible applications of photochromic polymers in erasable optical storage and imaging systems, in optical signal-processing, and in integrated optics. Chapter 2, by Crano, Kwak and Welch, deals with spiroxazines as fatigue resistant compounds, suitable for obtaining photochromic ophthalmic lenses that darken automatically upon exposure to sunlight. Manufacturing of commercial plastic photochromic lenses is also described. Chapter 3, by Whittal, mainly deals with the fundamental photochemistry of fulgides and fulgimides and points out their potential use in actinometry, optical data storage, as well as eyewear applications. Chapter 4, by Krongauz, covers photochromic liquid crystal polymers. It reports extremely interesting examples of photoinduced changes of mesophase arrangement and discusses nonlinear optics as an emerging technology which uses photons for information and image processing. Chapter 5, by Irie, describes light-induced variations of polymer conformation in solution and in gels, which, in turn, are accompanied by photostimulated changes of viscosity, solubility and shape of gels. Finally the last chapter, by Kamogawa, provides an overview of redox photochromism in viologen-based solid state systems.

It is a pity that the text does not cover several other interesting systems. For instance, photoresponsive membranes, which have been found to give photostimulated variations of their potential and their permeability, are not described. Photochromic poly(aminoacid)s, which were found to undergo elegant and large photoinduced order-disorder conformational transitions, are completely ignored. Therefore, although still valuable, the book does not give a well-balanced account of the present state of photochromic polymers. This however, might be the personal opinion of the reviewer who should not privilege his own work.

The title of the book, 'Applied Photochromic Systems', is slightly incorrect as in practice it means 'possible application'. It is likely that the described systems will be used in photochemical devices, but most of them still require further research work for future applications. I think that the book will be of interest to a wide range of readers, although those looking for the fundamentals of photochromism may be rather disappointed and may turn to other compendia. However, as an introduction to the potential applications of photochromic polymers, the book meets its aim and may stimulate new ideas in the field of these fascinating materials.

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Internal Stresses, Dimensional Instabilities and Molecular Orientations in Plastics

L. C. E. Struik
John Wiley & Sons, Ltd, Chichester, UK, 1990, 480 pages, £45
ISBN 0-471-92642-6

Another title for this book might have been '*Not* the Physical Ageing of Amorphous Polymers and other Materials'. It is a measure of the impact made by Struik's earlier book on physical ageing that his name is associated to such a degree with that topic. In fact, the new book scarcely mentions ageing. It discusses a range of issues bearing on the prediction of quality of formed plastic products.

There is much interest at present in the development of software tools for designers of polymer products and processes, to predict the quality and performance of new components at the design stage, before the expensive commitment of cutting a mould or die. This book makes a useful contribution by discussing the underlying (mostly phenomenological) principles which govern the features of formed plastics listed in the title: three features which usually detract from product quality. It includes results from a remarkably comprehensive series of experiments carried out some years ago at the laboratories of TNO in The Netherlands, and gives a detailed theoretical interpretation. Most of the experimental data are not freely available elsewhere, so the book will be an important source. Struik has structured his book in four self-contained parts, each dealing with a different topic.

Part I is a short section (only 13 pages) titled 'Dimensional instabilities due to volume relaxation', discussing the gradual densification of glassy polymers following cooling through the glass transition. It is this structural evolution that causes the changes in properties now referred to as 'physical ageing'. The emphasis here, though, is not on the changes in properties but on the volume relaxation itself. This has obvious implications for the dimensional accuracy of components; but Struik also makes interesting comments on the effects on the performance of plastic lenses and capacitors.

A substantial Part II follows, concerned with the dimensional instability arising from a polymer's 'memory' of stresses which acted during processing. Two matters are dealt with in depth: thermal shrinkage under heating without restraint; and shrinkage tension which arises under heating with complete restraint. Both are of considerable practical importance, but have been notable until now for a lack of careful, well-documented experimental data. Struik not only provides this, but also shows how the data can be interpreted in terms of the theory of non-isothermal linear viscoelasticity. In doing so, he identifies some useful rules of thumb which may simplify the reduction of data in practice.

In Part III Struik moves on to the prediction of frozen-in thermal stresses arising from inhomogeneous cooling from temperatures above the glass transition temperature: the usual case when plastic products are cooled rapidly during manufacture. The starting point is the elementary analysis well-known from the literature for inorganic glasses, where the material is modelled as an inviscid fluid at temperatures above the glass transition temperature and a Hookean solid with constant modulus below the glass transition temperature. It is followed by a discussion of the refinements necessary to accommodate

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