

Electrical Properties of Polymers—Chemical Principles

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This is a book of considerable detail and based on a most extensive literature review. By discussing the electrical properties of polymers from the chemist's point of view, the authors have provided the reader with a totally fresh approach, in contrast to that normally taken by the physicist or electrical engineer.

In no way does this detract from the value of this book to physicists and electrical engineers but is an enhancement of the conventional text. In addition to describing the chemical and physical origins of the various electrical properties, the authors have courageously attempted to suggest how this information may be put to practical use. Each of the four main properties of dielectrics, namely dielectric constant, tangent of dielectric loss, dielectric breakdown and electrical conduction, are comprehensively dealt with from a historical overview, through basic relationships and phenomena to possible mechanisms for controlling each factor by chemical or physical means.

This book is of value to final year undergraduate and postgraduate students in a variety of disciplines. All users of polymeric insulation from the polymer chemist and physicist to the manufacturing insulation engineer will find the text of great value.

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Size Exclusion Chromatography

B. J. Hunt and S. R. Holding (Eds.)
Blackie and Son Ltd, Glasgow,
1988, ix + 286 pages, £49.00
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Gel permeation chromatography or, as now seems to be the preferred name, size exclusion chromatography (s.e.c.) has been treated in several books or chapters of books. The publishers and editors evidently approached the production of this new work with a reasonable degree of confidence that they were offering an up-to-date survey of newer developments for the established practitioner and/or an

improved introduction for the beginner. On the whole, and with particular reference to the former of these aspects, it appears that their confidence was justified. The book is under the multiple authorship of 13 contributors and the 10 chapters are divided into three major sections: Part 1—Fundamentals, Part 2—Applications and Part 3—Special Techniques. There are also five useful appendices.

Part 1 is written entirely by the editors. In Chapter 1, Hunt gives a concise theoretical background and demonstrates that, unlike other non-s.e.c. liquid chromatographic separations, s.e.c. is an entropy controlled process. In the following chapter the same author provides adequate detail of the necessary equipment and hardware, the commercial sources of these being listed separately at the end of the book in Appendix 1. Despite, or perhaps because of the fact that data manipulation is normally effected via dedicated data-handling systems, the apparent ease of s.e.c. procedure often tends to mask the true complexity of the situation and results are regarded as more definitive than is truly warranted. This point is amplified in the last section of Part I 'Calibration and data analysis', where a constructive appraisal of the situation is presented by S. R. Holding, who is well-known in the UK especially for his expertise in operating a large s.e.c. facility with an equally large diversity of polymer samples examined. For this chapter, also, reference should be made to Appendix 2, which lists the recommended sources of narrow distribution calibrants.

The applications covered in Part 2 would by general consensus be regarded as those relating to systems which are not only practically important, but also rather difficult from the experimental and/or theoretical standpoint. Thus in Chapter 4, by Haddon and Hay, experimental procedures and findings are discussed for polymers which necessitate the use of s.e.c. at elevated temperature. These include polyethylene, polypropylene, poly(ethylene terephthalate), stereoregular forms of polystyrene as well as the newer engineering polymers, poly(ether ether ketone) and poly(phenylene sulphide). In the following chapter, 'Copolymer analysis', Mori leads us stepwise through the routes by which one can resolve the problem that properties of copolymers are influenced by distribution of not only molar mass (and hence size) but also of chemical composition. Procedures involving the combination of s.e.c. with other chromatographic methods are also discussed. Chapter 6, by Hillman and Heathcote, is concerned with industrially important species of low

molecular mass (\leq circa 1000 g mol^{-1}). For solutions of these, viscosity effects which limit usable concentrations of high polymers are essentially absent. Many of the systems covered are important in their own right, whilst others have an obvious relevance to polymers, namely waxes and hydrocarbon oils, complex mixtures under the umbrella heading of asphalts and pitches, coal liquids, explosives and propellants, oligomers and additives such as plasticizers and antioxidants. Aqueous s.e.c., which forms a small final section, comprises the whole of the last chapter of Part II by Kato. Although there are many features in common with normal non-aqueous s.e.c., complications are introduced if sample-support interactions are other than steric ones. Examples are provided by neutral, anionic, cationic and amphoteric polymers (e.g. proteins) and a useful list is given of suitable (invariably multicomponent) eluents.

The first of the three chapters within Part III is devoted to field-flow fractionation (f.f.f.), an alternative to s.e.c., which has been written by a pioneer of the field, J. Calvin Giddings. F.f.f. was developed at about the same time as s.e.c., but has developed less rapidly and is less well known because of major instrumentation problems. New commercial instrumentation has largely overcome this hurdle and, although the purist may argue that f.f.f. is competitive with, rather than a branch of, s.e.c., this reviewer believes that the chapter is a welcome one. Indeed, the author writes with such clarity and enthusiasm that the reader is left with a feeling of inadequacy that he is not already exploiting the demonstrated advantages of the techniques. The advantages of supercritical fluid chromatography (s.f.c.) have been realized only comparatively recently, although chromatography using a fluid above its critical point as mobile phase was reported in 1962. In Chapter 9, Bartle, Davies and Raynor review the basic principles, mode of operation and applications to polymer systems of this technique. The final chapter, by McHugh, deals with 'Hydrodynamic Chromatography' (h.d.c.) which is an extremely interesting variant on the general s.e.c. process in the respects that the columns are packed with non-porous rather than porous beads and the material to be fractionated is particulate rather than molecular. Particular attention is paid to the application of h.d.c. to the analysis of particle size and particle size distribution of sub-micrometre colloidal systems. Commendably and unusually, the author is able to explain the mechanism without recourse to the existing rigid mathematical treatment.

Unfortunately the text and appendices