

Book Reviews

Polymer-Polymer Miscibility

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Academic Press, New York, 1979, 370 pp, \$42.50.

Against a background of considerable industrial and academic interest in a wide variety of types of polymer blends, a book devoted to miscibility in polymeric mixtures is certainly timely.

The book consists of seven chapters, the first of which (69 references) is concerned with basic definitions and with such specific blends as PVC-nitrile rubber, poly(2,6-dimethyl-1,4-phenylene oxide)-polystyrene and with interpenetrating polymer networks. The references in this and subsequent chapters cover both the scientific and patent literature. Chapter 2 (198 references) is concerned with the basic relevant physical chemistry and has sections on general thermodynamic principles, phase separation phenomena, the solubility parameter approach to miscibility, the lattice theory, the equation of state approach and ends with a short outline of the thermodynamics of block copolymer systems. In chapter 3 (168 references) there is a discussion of the methods of determining the extent of miscibility in polymer-polymer systems. The observation of one or two glass transition temperatures by dynamic mechanical analysis, dielectric methods, dilatometry and calorimetric techniques, thermo-optical analysis and radioluminescence spectroscopy are commented on. This is followed by sections on light and electron microscopy techniques and on scattering methods including cloud point measurements, conventional light scattering, pulse-induced critical scattering and neutron and X-ray scattering. The chapter ends with a discussion of ternary solution methods and with brief descriptions of techniques such as rheological measurements, volume and heat of mixing measurements, melting point depression and n.m.r. spin-spin and spin-lattice relaxations. Chapter 4 (92 references) is concerned with methods of enhancing miscibility. These procedures are treated under the headings of minor structural modification, block and graft copolymers, interpenetrating networks, crosslinking and the introduction of specific interactions. Chapter 5 (311 references) is correctly titled a 'comprehensive survey of miscible polymer systems' and is conveniently organised under headings of polymer class (PVC, polystyrene etc.) and of molecular architecture (block copolymers, interpenetrating polymer networks etc.). The properties of miscible polymer systems are presented under the headings the glass transition, modulus-temperature behaviour, mechanical properties, electrical properties, rheological and viscoelastic behaviour, transport properties, crystallization and degradation in Chapter 6 (133 references). The book ends with a chapter (194 references) on the commercial utilisation of miscible polymer systems.

This is a clearly written, crisply produced and well referenced (up to and including part of 1978) work which should find its way onto the shelves of both academics and industrialists with interests in mixed polymer systems. It

functions well at both the level of a general review, and, particularly because of the large number of references and the comprehensive treatment of techniques, as a specialist text.

D. J. Hourston

Zeigler-Natta Catalysis and Polymerisation

John Boor Jr

Academic Press Inc. 1979. 670 pp, \$65.00

Science and technology usually advances in small steps, carried out by many people, and it is the gradual accumulation of these increments that leads to a notable advance. But once in a while a discovery is so significant, that in a single step it produces a major advance that has an immediate and significant effect on both science and technology. Such were the key discoveries in polymer science made in the laboratories of K. Zeigler in 1953 and of Natta in 1954 — discoveries that triggered off scientific and technical research and development not previously seen in the history of macromolecular science.

A complete book on Zeigler-Natta catalyst and polymerization is timely now that more than two decades have passed since the initial discoveries, and the rate of publication of new papers and patents has lessened to a manageable level. In writing this book, the late Dr John Boor, himself a distinguished worker in this field, had done a commendable task and has produced a most thorough, comprehensive and yet very readable account of the subject that the reviewer has read.

The book tells the Zeigler-Natta story in depth and in a manner suitable for reading by chemistry and engineering graduates, and by industrialists involved in the commercial use of Zeigler-Natta catalysts. The author has done an amazing job in coping with the voluminous publications on the subject — over ten thousand papers and patents have appeared on the many aspects and uses of the catalyst — and although references are restricted to a small portion of the total publication the author has discussed all the more important papers in detail and overall has presented the literature findings accurately and fairly.

The book is divided into 23 chapters, and each is written independently coherent as regards each particular subject area. The first three chapters cover the subject in a broad way and are ideally suited to the reader who wishes to obtain an overview of the subject. The remaining chapters cover seventeen important subjects of Zeigler-Natta catalysis and polymerization of olefins, dienes and other types of monomers. The opening chapter reviews the highlights of Zeigler-Natta (ZN) catalysts and polymerizations. Chapter 2 describes the genesis of the ZN catalyst and briefly recalls the important contemporary developments. The detailed definition of the catalyst, the stereochemistry of the polymers and the analytical methods used to identify and evaluate the stereochemical content of the polymer are summarized in chapter 3.

Although a very large number of catalyst

systems have been investigated some have emerged that can be cited as being more important from the point of view of mechanistic studies and for commercial usage. These and other factors which determine the use and behaviour of the catalyst are discussed in chapter 4 for olefins and in chapter 5 for dienes. The ZN catalyst has been used in soluble, colloidal and heterogeneous forms. The advantages or otherwise of each type as catalyst activity, morphology of the polymer particles, comonomer content of a copolymer, stereochemical structure etc. are elaborated in chapter 6.

Recently vapour phase polymerization (no solvent added) has been reported as offering economic advantages and the main feature of this and the slurry and solution processes are discussed in chapter 7. The next chapters deal with the fascinating aspects of ZN catalysts such as the growth of the polymer particle from the catalyst particle and the influence of third components (donors) on catalyst behaviour.

In practical applications the molecular weight of the polymer needs to be controlled and the many methods developed for termination of polymer growth are described in chapter 10. Since the oxidation state of the catalyst affects the structure of the active centre a separate chapter is devoted to describing the experimental methods used to determine the oxidation state. Many examples disclosed in the literature of metal alkyl free catalysts (i.e., no alkyl added) and their relation to ZN catalysed are summarized and discussed in chapter 12.

The next five chapters (13-17) are concerned with the mechanism for the initiation and propagation for olefins and dienes, the mechanism for stereochemical control of olefins and conjugated and non-conjugated dienes and the mechanisms for stereochemical control of stereoselective and stereoelective isotactic propagations. These sections provide an excellent critical survey of the mechanistic views that have been published. The next chapter focusses attention of the basic kinetic results, the nature of the polymerization rate curve and of the polymerization product — and includes a survey of the nature and concentration of active centres, the living character of the polymer chain and the importance of diffusion of the olefine to the centres.

Similarly the kinetic features of copolymerization and block polymerisation are treated in chapter 20 and 21. Although ZN catalysts are best suited for the polymerization of olefins and dienes many other types of monomer have been found active with different forms of ZN catalysts such as allenes, acetylene, polar vinyl and related monomers. Chapter 19 describes the many different monomers that have been studied and the final section (chapter 23) reviews the many other reactions of binary mixtures of metal alkyls and transition metal salts and these include radical and cationic polymerizations, metatheses, oligomerizations, isomerization, hydrogenation and alkylation.

The book covers references up to the end of 1972 and a supplementary bibliography updates the references from 1972-78.

This book can be recommended without reservation to all interested in the Zeigler-Natta discoveries and the subsequent developments as the most fascinating account of this beautiful and unique catalyst.

C. E. H. Bawn