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PART II Characterization of Polymers

Preface to the Third Edition

The second edition of this book was published at the start of a decade during which the discipline of polymer science saw several major developments come to fruition, including methods for effecting 'living' radical polymerization, dendrimer and hyperbranched polymer syntheses, use of metallocene catalysts for the polymerization of olefins, ring-opening methathesis polymerization, methods for the synthesis of inherently conducting polymers and their use in electronic devices, advanced high-performance polymer composites and specialized biomedical applications (both structural and functional). Theoretical understanding of polymers matured further during this time with scaling concepts, reptation theory, mechanisms for toughening polymers, and understanding of phase separation behaviour of multicomponent polymer systems becoming established in mainstream polymer science. Since the beginning of the new millennium, these advances have evolved to the point where they are now routine and used by the many scientists and engineers working on polymers in both academia and industry. Furthermore, during the past 20 years, the significance of developments in polymer science has been recognized by award of several polymer-related Nobel Prizes in both chemistry and physics. Over the same period, the use of polymers has continued to grow and diversify, particularly into medicine, electronics and aerospace applications.

Thus, the content of the second edition had become somewhat dated by midway through the past decade and preparation of a third edition was an imperative. In planning the new edition, we have taken the opportunity not only to include the science which underpins the important new developments and to bring the subject matter up to date, but also to completely reorganize the book into a more visibly coherent form that, we hope, readers will appreciate, whether the book is used as a basis for teaching or for learning the fundamental aspects of contemporary polymer science. The original 5 chapters have been reorganized into 25 self-contained chapters grouped into 4 parts that focus on (1) concepts and synthesis, (2) characterization, (3) structure and morphology, and (4) properties. Whilst retaining the overall balance between these themes, the content of each previous chapter has been reconsidered in detail, revised, reorganized where appropriate and expanded significantly to include the new developments. Anyone who is familiar with the second edition will recognize the previous material, but also should instantly feel the freshness and accessibility of the new structure.

Each of the chapters on polymer synthesis (Part I) has been expanded to include the most important new developments at a depth designed to inform the selection of appropriate method(s) for the synthesis of particular polymer structures and to facilitate the understanding of polymerization mechanisms and kinetics. Some of the more obvious new topics are 'living' radical polymerization, various methods for the synthesis of conducting polymers, strategies for the synthesis of dendrimers and hyperbranched polymers, metallocene polymerization and strategies for block copolymer synthesis. There also are many other less obvious additions, such as modern methods for the evaluation of rate coefficients in radical polymerization, catalytic chain transfer, non-linear radical polymerizations, free-radical ring-opening polymerization, supramolecular polymers and graft copolymer synthesis. Additionally, polymerization mechanisms have been made more explicit by showing electron movements.

The coverage of polymer characterization (Part II) has been expanded to show the complete derivations of the Flory–Huggins theory and the related theory for phase separation behaviour of polymer solutions, and to give a more thorough description of dynamic light scattering. New topics such as diffusion, solution behaviour of polyelectrolytes and field-flow fractionation methods have been added. And there is a major expansion of the coverage of spectroscopic methods, to which is devoted a complete chapter with new topics that include UV-visible spectroscopy, Raman spectroscopy, use