

to study ionic reactivity and intermolecular interactions in supercritical solvents. Buelow and coworkers report on the hydrothermal destruction of organic wastes from the production of nuclear materials. Chapters by Tester and coworkers and by Savage and coworkers also deal with the treatment of organic wastes in supercritical water, while Ding et al. report encouraging results on the use of heterogeneous catalysts in supercritical water oxidation of aromatic hydrocarbons, and Subramanian and Joona discuss the benefits of operation at supercritical conditions on the mitigation of catalyst deactivation during the isomerization of 1-hexene.

The section on Special Topics and Applications lacks the thematic coherence of the remaining groupings. Sunol and coworkers present an interesting comparison of aerogel catalysts prepared using supercritical drying and a novel supercritical extraction route and find that the latter allows processing at substantially milder conditions. Two instructive chapters, one by Downey et al. and the other by Mitton et al., address the key and still unsolved issue of corrosion in supercritical water oxidation technology. Bourhis et al. show that lower required inlet temperatures and shorter residence times can result from the addition of small amounts of strong oxidizers to the feed of supercritical water oxidation streams. It is not clear why these three chapters were not included in the section on Chemical Reactions.

Finally, the section on Supercritical Fluids in the Forest Products Industry contains a useful and well-written review by Kiran on the potential of supercritical fluids for delignification, waste treatment, chemical conversion of cellulosic wastes, paper recycling, and wood impregnation. Also noteworthy is a chapter by Teja and coworkers on the supercritical extraction of Taxol, a promising therapeutic alkaloid with a broad range of antileukemic and tumor-inhibiting activity.

The state of the art of the fundamentals and applications of supercritical fluids is well documented in this useful book. While some important topics such as polymerizations in supercritical fluids and particle formation are not represented, this volume is an important and welcome addition to the literature on supercritical fluids.

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## Polymer Surfaces from Physics to Technology

By Fabio Garbassi, Marco Morra, and Ernesto Occhiello, Wiley, New York, 1994, 462 pp., \$95.00.

As the authors state in their preface, the science and technology of polymer surfaces have grown rapidly, resulting in a prolific body of literature that is spread over a large number of journals that deal with a number of different fields. Their goal is to present a comprehensive treatise on the subject that starts from a consideration of the fundamental physical principles that dictate polymer surface properties and proceeds to review important aspects of real-world applications. Toward this end, the book is divided into four sections: Introductory Remarks concerning fundamental surface forces and surface dynamics; Characterization Methods; Modification Techniques; and Applications.

The book begins with a chapter on the origin of surface properties that entails a brief review of surface forces. Van der Waals forces and electrostatic interactions are first treated, leading up to an explanation of the DLVO theory of colloid stability. The chapter continues by highlighting the effects of structural interactions at interfaces, such as ordering at short distances due to geometrical constraints and solvation forces, and steric forces between adsorbed polymer layers. The emphasis is clearly taken from the perspective of a colloidal scientist and provides a fairly comprehensive background for readers interested in solution interfaces. There is little emphasis on short-range interactions, including hydrogen bonding and acid-base interactions that are important to problems involving bulk polymer systems, such as polymer-metal adhesion and wetting. Also absent is any attempt to relate these fundamental surface forces to important measurables such as interfacial tension and adhesion strength, although these topics do receive further attention in later chapters devoted to characterization and applications. The second chapter does well to bring attention to the often neglected fact that polymer surface structure and properties may depend strongly on time, temperature, and the environment. Several examples of experimental evidence demonstrate the importance of dynamic processes at interfaces: coalescence of crazes, surface reconstruction of copolymers, aging of plasma-treated surfaces, and reorganization of side chains and functional groups at surfaces.

The second section of the book describes substantively current techniques available for the characterization of polymer surfaces. The principles that underlie each of the methods are described, followed by a brief overview of considerations regarding instrumentation and several examples of experiments that illustrate the nature of information that can be obtained from application of each technique. Chapter 3 on spectroscopic techniques is organized according to the nature of the physical probe employed: ions, for secondary ion mass spectroscopy, Rutherford backscattering and ion scattering spectroscopy; electrons for X-ray photoelectron spectroscopy; and photons for ultraviolet, visible and infrared spectroscopy techniques. An important comparison of the information obtained by these techniques and practical considerations associated with their application is also provided. After a brief review of classical surface thermodynamics, Chapter 4 focuses primarily on characterizing surface energetics of solid polymers through contact angle analysis. The chapter is divided into three sections: methods for contact angle analysis, the origins of contact angle hysteresis, and semiempirical treatments for inferring surface energetics from contact angle data. Chapter 5 describes new and emerging polymer surface characterization techniques, including direct surface force measurements, surface charge measurements, and neutron reflection.

Part 3 of the book describes techniques available for the modification of polymer surfaces and is organized according to the nature of the method: physical, chemical or bulk modification. A chapter on physical methods provides short overviews of surface modification by bombardment with high-energy species (e.g., flame, corona, plasma, electrons, and ions) and by coating thin films (sputtering and metallization). Methods involving direct chemical surface reactions receive a more substantive discussion. Topics covered include wet chemical treatments, such as etching, oxidation, hydrolysis and surface functionalization reactions, and methods to promote surface grafting reactions. A discussion of bulk modification centers on the design of surface composition in multicomponent polymeric systems. The qualitative aspects of surface segregation phenomena are covered for polymer blends and block copolymers.

Part 4 discusses applications in which surface modification is an essential element in performance. This is the most effective and successful section of the

book where the authors emphasize how the fundamentals and characterization techniques described in previous chapters can be built on to develop polymers with practical applications. The authors cover an impressive breadth of applications that should be valuable to virtually anyone that is active in the industrial application of polymer systems. Wettability is first discussed, as it impacts later sections on adhesion and biocompatibility. The focus is on creating hydrophilic or hydrophobic extremes on polymer surfaces that generally lie somewhere in-between. The importance of surface aging and rearrangement is clearly demonstrated for hydrophobic surfaces, and the use of silicones and fluorocarbons as water-repellent hydrophobic surface treatments is illustrated. The following chapter on adhesion focuses on four major mechanisms that can contribute to adhesion: mechanical interlocking, interdiffusion of polymer chains, electrical interactions, and chemical interactions. The treatment provides little theoretical background to identify the relationship between adhesion and these mechanisms, but provides an excellent practical background of how to modify a

number of commercially important polymers to enhance adhesion. The chapter on barrier materials describes commercial processes for creating multilayer films for applications in the packaging industry. Two types of processes are distinguished: the formation of laminates by processing of blends and true surface treatments such as metalization chemical deposition and chemical modification. A chapter on biological materials presents an excellent and comprehensive review of the crucial role of polymer interfaces in the biological environment. The effects of various surface parameters on interactions with biological materials are discussed, followed by a review of the literature on contact lenses. The final chapter on applications concerns friction and wear of polymer surfaces. Two general topics are discussed: the general importance of lubrication in polymer compounding and coatings technologies to control friction.

The authors have tried to bridge the gap between scientists and technologists, a difficult task to say the least. In a qualitative fashion they have achieved some success in achieving this goal, and thus the book should be appealing to

industrial practitioners of surface modification. The chapters are generally well referenced and treat each subject with considerable breadth. The book also presents a comprehensive review of available surface analysis methods that will be valuable for readers looking for a technique to determine specific polymer surface properties. It is lacking, however, in any real theoretical description of polymer surfaces from a molecular point of view. The reference database is also several years out of date, a significant disadvantage in a rapidly advancing field such as polymer surfaces. Scientists and students interested in a timely fundamental treatise on the molecular principles governing polymer surface properties must therefore look elsewhere. As the authors point out in the preface, however, their emphasis is on applications, and thus the general appeal of this book is to technologists interested in the practice of polymer surface modification and analysis.

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