bulk structure, this chapter starts with a discussion of the most common bulk lattice structures. The discussion focuses on how these lattice structures result from the ionic nature of oxides and the relationships between bulk and surface structure. As pointed out by the authors, there have been relatively few detailed studies of the structures of oxide surfaces. Thus, this section focuses for the most part on surfaces resulting from ideal termination of the bulk. For those systems that have been studied in detail, however, descriptions of real surfaces and surface reconstructions are included. For each class of oxides, a table of references to experimental studies (primarily LEED results) is provided. The end of this chapter includes a brief discussion of steps and defects on oxide surfaces. Although it would have been good if a discussion of the use of calculational approaches to predict oxide surface structure were included, overall this chapter provides a good introduction.

The following three chapters focus on the physical properties of metal oxide surfaces. Chapter 3 is devoted to vibrational properties, specifically lattice phonon modes. Although this chapter is written with the novice in mind, a general knowledge of solid state physics is useful in understanding the origin of the equations that describe lattice vibrations. The bulk of this material deals with the characterization of surface phonon modes using high-resolution electron energy loss spectroscopy (HREELS) and to a lesser extent IR and Raman spectroscopies. A brief section on the use of HREELS to study adsorbate vibrations on oxide surfaces is also included. This latter section would have been better placed in Chapter 6, which focuses on adsorption on oxide surfaces.

The electronic properties of nontransition and transition metal oxide surfaces are discussed in Chapters 4 and 5, respectively. Chapter 4 is effectively divided into three parts: the electronic structure of metal oxide surfaces, experimental methods of surface electronic structure determination, and case studies of the electronic properties of nontransition metal oxide surfaces. The first section provides an introduction to the various models which describe the bulk electronic structure of oxides. This is followed with a discussion of how bulk defects and doping can alter electronic and optical properties. As was the case with Chapter 3, this discussion is on a rather basic level and is intended to provide the reader with an introduction to the subject, rather than a detailed theoretical framework for describing electronic properties. A section on electronic excitations in oxides describes band gap excitations in insulating oxides and conduction band plasmons in semiconducting oxides. This is followed with a discussion of the electronic properties of metal oxide surfaces and how these properties may differ from those of the bulk. The role of surface defects such as oxygen vacancies and surface band-bending in semiconducting oxides on surface electronic properties are also mentioned.

The second part of Chapter 4 provides a very brief introduction to the experimental techniques most commonly used to characterize the electronic properties of metal oxides. The bulk of this discussion focuses on photoemission spectroscopies such as XPS and UPS. The remainder of this chapter provides an excellent review of previous studies of the electronic properties of nontransition metal oxide surfaces. The bulk of this material deals with MgO, Al_2O_3, ZnO, and SnO_2. The first two serve as examples of insulators, while the latter two serve as semiconductors. Topics of discussion include variations in surface electronic properties with crystallographic orientation and the electronic properties of surface defects. The influence of surface treatments such as sputtering and annealing on surface electronic properties is also illustrated.

Chapter 5 begins with a survey of the electronic structure of transition metal oxides. The approach used here is to highlight the differences between transition and nontransition metal oxides. The authors do a nice job of illustrating how inclusion of the *d*-orbitals in the valence states for transition metal oxides result in complex behavior. As with the discussion of electronic properties in Chapter 4, this section does not provide detailed theoretical descriptions, but rather introduces the most important parameters and provides simple examples which illustrate their effect. Specific subjects covered here include variable oxidation states and nonstoichiometry, the failure of simple band models, and crystal field splitting. The remainder of the chapter uses a variety of examples from the literature to illustrate these effects on transitional metal oxide surfaces. This section provides a fairly comprehensive review of previously published surface science studies of transition metal oxides.

Chapter 6 deals with chemisorption on metal oxides. Although this chapter does not provide a comprehensive review of the literature in this area, it provides a good introduction to the study of adsorbates on oxides and is an excellent starting point for anyone interested in this area of study. The initial portion of this chapter is broken into sections on specific adsorbates such as H_2, H_2O, CO, CO_2 and SO_2. There are also sections on the interaction of organic molecules with oxide surfaces. These sections are rather brief, however, and it would have been nice if the authors had spent a little more time on this material, since this is of critical importance in many applications such as catalysis and chemical sensors. The latter portion of the chapter focuses on the adsorptive properties of different classes of metal oxides. The chapter is well referenced and contains numerous tables that point to a wide range of chemisorption studies. Researchers new to the field will no doubt find this a valuable resource.

Overall, this book provides an excellent introduction to the field of surface science of metal oxides. It has relatively few shortcomings and is likely to become the classic text in this area. It already occupies a prominent spot on my bookshelf and should be required reading for anyone new to the field.

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Polymer Devolatilization

R. Albalak, ed., Marcel Dekker, New York, 1996, 772 pp. $225.00

This monograph is a successful update concerning the state of the art in the highly specialized area of devolatilization of polymer solutions, emphasizing the work of the past decade. The book attempts to cover the physico-chemical and transport foundations (Chapters 2–7), the technology and design principles of the most commonly used devolatilizers (Chapters (9–13), and several case studies on selected polymer/solvent combinations (Chapter 14–17), followed by chapters on the perceived future developments (Chapter 18) and the laboratory techniques currently used for analysis of the vapor phase (Chapter 19). The appendices provide data on the vapor-liquid equilibria, albeit only a subset of the property functions required for a rational interpretation of devolatilization. The book is supplemented by a compi-

lation of abstracts of devolatilization work published in the English language between 1983–1994.

The contributed chapters–13 from industry and 17 from academia-form a fairly coherent text with a distinct, industry oriented, R&D flavor. The foundation chapters deal with the solution thermodynamics, solvent diffusion, bubble nucleation and growth. Perhaps in view of its complexity, the introduction of solution rheology is omitted, as well as the nonisothermal non-Newtonian flow mechanics and interactions within crowded bubble populations. Only *ad-hoc* references to such material appear in the chapters on the individual equipment configurations. In general, there is somewhat of a mismatch between the highly simplified fundamentals presented in the introductory chapters and the harsh reality of industrial devolatilization treated later on, without a due warning to the reader. Overall, however, the quality of writing makes reading of the introductory chapters worthwhile, an easy introduction to the subject.

The chapters dealing with the devolatilization processes in their respective equipment environments of the falling-strand, slit, wiped-film, and drag-flow (extruder) devolatilizers utilize varying subsets of the analytical apparatus available for interpretations of their working. As a whole, the process oriented chapters give a comprehensive account of the existing technology and of the design tools available.

Admittedly, devolatilization of polymer solutions involves significant, not fully understood, interactions between rheology and diffusion in an environment of nonisothermal, non-Newtonian flow. Even in the relatively slow devolatilization (degassing) mode, effects of nucleation on the mass-transfer rates are acknowledged, but remain obscure. In practice, devolatilization designs tend to be empirical, relying frequently on technology transfer from areas perceived as related. The text does not attempt to provide critical comparisons between the alternative, and often competing, technologies. Understandably so, not all chapters have been written from the same perspectives; some emphasize the chemical engineering principles, others the mechanical features of the equipment. Little cross-referencing between the chapters has been done to bring out the common features of this admittedly fairly narrow family of operations. An integrated chapter on scale-up would be most useful as the scale rules for most of these operations are expected to be closely related. Serious readers of this book might also benefit from added information on the limitations of the individual chapters' approaches, not an easy task for a monograph written by multiple authors, chemists and physical chemists, mechanical and chemical engineers.

The book nevertheless manages to convey a fairly convincing case of a functioning technology, despite its complex, incompletely understood underpinnings. It provides a fairly complete technological guide and highlights the merits of the individual techniques. The partial support by mathematical modeling for the bubble-free operation of the slit devolatilizer, single- and twin-screw devolatilizers, and for the foam-enhanced devolatilization in the counter-rotating twin-screw extruder, provides a stimulating, and not necessarily complete, conceptual view of devolatilization.

Despite broad and diverse authorship, the book gives the various devolatilization techniques a reasonable degree of common identity. The book contains sufficient detail to inform an experienced engineer about the state of the art in polymer devolatilization while serving as a readable introductory source of background and reference material for the novice to polymer finishing operations.

Albalak's book is not another book on polymer extrusion. It concerns the rapidly evolving subject of industrial mass-transfer operations on liquid polymeric systems. This book is among the handful of successful books available to date attempting to organize and disseminate information in an area led by industrial R&D, followed by academic scientists, in their shared quest for new and more efficient polymer technologies.

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