

good overview of particle motion in linear accelerators.

The physics of electron storage rings is the topic of the fourth chapter, which emphasizes storage rings used to provide synchrotron radiation. For modern sources, the experiments that use such radiation often require very high-brightness x-ray beams from insertion devices placed in the storage ring lattice. After introducing the radiation physics of electrons moving in magnetic fields, Lee discusses the damping of the synchrotron motion and betatron motion—along with radiation excitation of this motion due to quantum effects. The last section in this chapter discusses lattices that provide very low emittance electron beams, which are essential to the generation of high-brightness x-ray beams. Missing from this chapter is a detailed discussion of beam-beam effects in  $e^+e^-$  colliders.

The exercises distributed throughout the book are an important supplement to the reading and serve to reinforce the material being covered. The description of experimental measurements on beams in operating accelerators, especially the transition to chaotic behavior, provides an important confirmation of the sometimes tedious equations describing the phenomena. On the negative side, there is little discussion of the parameters of accelerators that are driven by the needs of nuclear and particle physicists—higher energy, luminosity, and beam intensity, to name a few.

I would recommend this text to a graduate student wishing to do thesis research in accelerator physics. The large number of formulas and the excellent table of contents and index make the book a very useful addition to the library of a scientist or engineer already in the field.

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## X-Ray Scattering from Soft-Matter Thin Films: Materials Science and Basic Research

▶ Metin Tolan  
*Springer-Verlag, New York, 1999.*  
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The importance of x-ray scattering techniques for elucidating the struc-

ture of condensed matter is evident from their ubiquitous application to a diverse variety of materials. Technical and theoretical advances in x-ray scattering in recent years have been particularly noteworthy in the arena of so-called soft materials, which include polymers, molecular crystals, and liquid crystals. Considerable improvements in x-ray sources, optics, and detectors are making x-ray scattering methods more readily available, while improved understanding of scattering principles is helping to reveal the rather complex architectures characteristic of soft materials. The impact of these advances has been particularly significant for soft-matter thin films, the subject of Metin Tolan's *X-Ray Scattering from Soft-Matter Thin Films*.

Tolan's book primarily addresses the techniques of x-ray reflectivity and off-specular and coherent x-ray scattering. Grazing-incidence diffraction is not described, although Tolan does refer the reader to several key reviews on the topic. (Inclusion of this technique, which is increasingly being used to measure Bragg scattering from ordered Langmuir monolayers, would have made the book more comprehensive.)

Tolan's overall presentation is exceptionally well organized, with experimental methods and examples discussed following a description of the underlying theory. The book's six principal chapters cover three topics: reflectivity of x rays from surfaces, reflectivity experiments, and advanced analysis techniques; statistical description of interfaces and off-specular scattering; and x-ray scattering with coherent radiation (this last topic is treated rather briefly since it has been limited by the requirement for high-brilliance synchrotron sources). Tolan appropriately reserves a description of the Hilbert phase and its relationship to the phase of the structure factor for an appendix.

The strength of this book is the coupling of expert descriptions of scattering principles with carefully chosen examples of thin films, with clear comparisons of theory and experimental data. The examples will make the text accessible and more manageable for beginning practitioners, although the book will best serve readers who are already comfortable with the basic principles of scattering theory. (The introductory material in chapter 2 is beyond the level of those new to x-ray scattering.)

Tolan systematically provides brief explanations of the technologi-

cal and fundamental issues pertaining to each example, weaving together theories that describe the structure and properties of soft-matter thin films and the scattering methods that provide experimental verification of these theories. Particularly well described are the application of reflectivity and off-specular reflectance to the characterization of capillary waves in liquid and polymer films, the influence of experimental parameters such as film thickness and substrate, and the correspondence of these factors to theory. Several illustrative examples of block copolymer films demonstrate the utility of reflectivity and nonspecular scattering in characterizing surface structure, both lateral and vertical, with respect to conformal and anticonformal polymer film structures on patterned substrates, phase segregation, and island formation at film surfaces.

Throughout the text, Tolan points out the advantages and disadvantages inherent in scattering methods. For example, the phase problem is addressed in detail, accompanied by an excellent description of the limits this problem imposes on the structure of solutions. An equally good description of the experimental parameters and sample characteristics that enable users to circumvent this problem is included. Tolan also pays considerable attention, in a chapter dedicated to the statistical description of interfaces, to the influence of roughness on scattering, providing a thorough explanation of the correlation functions for describing roughness. The book is well referenced and clearly conveys materials systems and behavior that are amenable to characterization by thin-film scattering techniques. It should be an asset to any research group beginning, or currently involved in, the characterization of thin films by x-ray diffraction.

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### Geophysics

**Annual Review of Earth and Planetary Sciences, Vol. 27.** R. Jeanloz, A. L. Albee, K. C. Burke, eds. Annual Reviews,