Physics of Thin Films, Vol. 13

Edited by Maurice H. Francombe and John L. Vossen

(Academic Press, 1987)

The 13th volume of *Physics of Thin Films* contains five excellent review chapters. The first two deal with film deposition, the third with ion beam modification of films, the fourth with laser-induced etching, and the last one with contacts to GaAs devices.

The first chapter, by T. Takagi, reviews ion-cluster-beam deposition, a technique he introduced more than 16 years ago and has developed into both a deep science and a fine art. First, he considers the formation and properties of clusters. Then he explains how accelerated ionized clusters provide the kinetic energy needed to promote surface migration so that the atoms find their proper lattice sites even at substrate temperatures substantially lower than required for epitaxy by conventional methods. Takagi then gives examples of various materials that have been deposited as films and discusses factors affecting their crystallinity.

In the second chapter R.F. Bunshah and C. Deshpandey review the Reactive Evaporation Process pioneered by Bunshah. The technique consists in reacting a metal vapor produced by thermal evaporation with a gas to form a solid compound that deposits as a film. The gas may be preionized to make it more reactive. This technique is most useful for synthesizing films of refractory materials, such as oxides, nitrides and carbides.

In the third chapter, U.J. Gibson is concerned with the ion beam deposition and processing of optical films. This necessarily includes a review of ion generators and their use in film deposition, overlapping briefly with the coverage of the first two chapters. The author, being primarily interested in optical films, concisely summarizes optical and structural properties of thin films and of methods for assessing their properties. Ion bombardment before, during and after deposition affects the properties of the optical films; these are mostly oxides.

The first three chapters have extensive references to very recent literature.

In the fourth chapter, C.I.H. Ashby reviews the laser-induced etching of thin films by thermal ablation and photochemical reaction with either a gaseous or a liquid ambient. This process is important in microlithography, hence the appropriate concerns for resolution and depth-to-width aspect ratio. There are useful tables listing the wavelengths suitable for etching numerous organic and inorganic materials.

Contacts to GaAs Devices is the subject of the last chapter, by J.M. Woodall, N. Braslau, and J.L. Freeouf. The authors review the history of metal-semiconductor interfaces, and there is a good discussion of Fermi-level pinning at the surface and how it is affected by oxide layers in various III-V compound semiconductors. Still, the problem of making a low-resistance ohmic contact is very difficult. Heavy doping near the interface and the use of an InAs layer to form a conducting heterojunction are possible solutions.

All the chapters go into considerable depth to please the specialists, but the book is also good for tutorial value and should appeal to a broad readership.

Reviewer: Jacques I. Pankove is professor in electrical and computer engineering and manager for materials and devices at the Center for Optoelectronic Computer Sciences. His specialty is in semiconductors and optoelectronics.

Constitutive Laws and Microstructure

Edited by D.R. Axelrad and W. Muschik

(Springer-Verlag, 1988)

This book is an account of invited presentations and discussions from the seminar on "Constitutive Laws and Microstructure" held at the Wissenschaftskolleg (Institute for Advanced Study) Berlin, West Germany, February 23-24, 1987. The seminar was held in cooperation with the Institute of Theoretical Physics and the Hermann Fottinger Institute of the Technical University, Berlin with the purpose of discussing some recent developments in the theory of materials.

The title might be misleading because the book actually covers a relatively narrow range of topics, representing work done within the time of a short seminar.

Such as it is, this volume might be useful to familiarize readers with the fundamental issues of material theories and to indicate possible ways future research may aid in formulating more rigorous material theories.

The main topics in the book include thermodynamics of materials presented by W. Muschik's paper on thermodynamical constitutive laws; thermodynamical considerations on plastic and viscoplastic behavior by Th. Lehmann; metal plasticity as a problem of thermodynamics by J. Kestin; and description and simulation of shape memory by I. Muller.

Other topics include the stochastic processes and material behavior covered by papers such as "Markov—Chains as Models for the Inelastic Behavior of Metals" by E. Steck and "Stochastic Analysis of Structural Changes in Solids" by D.R. Axelrad.

The book also deals with the constitutive relations for simple fluids and microphysics of solids. Here we find papers on molecular dynamics: "Test of Microscopic Models for the Material Properties of Matter" by S. Hess and W. Loose; "Localization of Waves Due to Disorder in Solids" by Ch. Enz; "Electromagnetic Control of Material Properties in Multipole Elastic Composites" by R. Hsieh; "Thermodynamic Modeling of Polymers in Solution" by G. Maugin and R. Drouot; and "A Microphysical Model for Crystallizing Polymers" by K. Wilmanski.

Discussions with the symposium's participants are also published and give an idea of the problems treated in the meeting as well as the extent and nature of the scientific community's interest in this area.

Reviewer: Minko Balkanski is professor of physics and director of the Solid State Physics Laboratory at the University of Pierre and Marie Curie, Paris.

Diffusion Processes in High Technology Materials

Edited by D. Gupta, A.D. Romig Jr., and M.A. Dayananda

(Trans Tech Publications, 1988)

The 277-page volume contains 21 papers presented at the symposium on "Diffusion Processes in High Technology Materials" sponsored by the Atomic Transport Activity of the American Society for Metals. The symposium was held during the 1987 Fall Meeting of The Metallurgical Society in Cincinnati, Ohio. The papers were originally published in the journal *Diffusion and Defect Data.*

The 21 invited and contributed papers cover a broad range of topics in diffusion. Several papers deal with diffusion problems related to electronic device applications, such as diffusion barriers, electrical contacts, and interconnects for VLSI packaging. Many of the papers discuss the fundamental aspects of diffusion in solids (including diffusion in semiconductors, crystalline and amorphous metallic thin films, and in nanocrystalline materials) as well as more traditional topics such as oxidation, interfacial segregation, and grain growth. Various experimental techniques for diffusion studies are examined with additional focus on several emerging and promising experimental techniques, in particular, high resolution transmission electron microscopy and tunneling microscopy.

Most of the papers are review papers written by experts active in their fields. Ap-