Thermophysical Properties of Materials

G. Grimvall

(Elsevier Science Publishers, 1986)

Thermophysical Properties of Materials is Volume XVIII in a series of monographs on selected topics in solid state physics being published by Elsevier's North-Holland Physics division. Göran Grimvall, a well-known researcher in the field, has combined theory, approximations, insights, and rules of thumb in an attempt to bridge the (often vast) gap between fundamental solid state physics and its application to engineering materials. It is a tribute to his working knowledge of the field that in only 348 pages he has succeeded in producing a guide for the perplexed.

The coverage is broad and quite varied in extent. Lattice and defect energetics and dynamics are discussed extensively along with thorough descriptions of elastic properties and heat capacity. Separate chapters are devoted to thermal expansion and to electrical and thermal conductivity. Of particular interest are the final chapters on composites, anisotropic materials, and correlations and estimation. The author addresses the thermophysical properties by assessing the relative magnitudes of effects, providing a working, physical sense of important effects, and pointing out potential pitfalls in analysis. Because of the extent of coverage, no one topic is treated exhaustively but the book does direct the reader to fruitful paths for further exploration.

I found only a few minor matters that I would rather have seen given a different treatment. In discussing entropy of mixing, Grimvall calls what is generally referred to as the entropy of mixing (ΔS^m), the *excess* entropy of mixing (ΔS^{xs}). In the figure (4.10) illustrating his point he appears to have actually plotted from the literature not ΔS^{xs}, as stated in the figure caption, but ΔS^m, although the legend seems incorrect. In the discussion he states that ΔS^m is approximately equal to the ideal entropy of mixing (ΔS^{id}). However, it is the departures from ideality, given by $\Delta S^{xs} = \Delta S^m - \Delta S^{id}$ and the enthalpy of mixing, that are of chief concern. If all solutions had a nearly ideal entropy of mixing, the world would be a simpler place.

In another section, Grimvall makes an important distinction between heat capacity at constant pressure and heat capacity reduced to a fixed pressure. Another important distinction which I would like to have seen included is the one between heat capacity at saturation (usually, what is actually measured) and that at constant pressure or volume. The same distinction for other thermodynamic functions would also apply.

Despite these minor complaints, I can recommend this book to workers in thermophysics and those interested in the application of theory to practical systems. Because of the brevity of systematic development it is not well suited for instructional use, but as a brief guide for experienced workers it is admirable.

Reviewer: Leonard Leibowitz is a group leader in the Chemical Technology Division, Argonne National Laboratory. His work deals chiefly with the physical chemistry of nuclear reactor materials.

Chemical Vapor Deposition for Microelectronics: Principles, Technology and Applications

Arthur Sherman

(Noyes Publications, 1987)

This book contains an overview of chemical vapor deposition (CVD) as it is used in the production of silicon-based microelectronic devices. Selected examples from the literature cover various aspects of this field, including descriptions of some of the underlying chemistry and physics of CVD, discussions of materials, processes and equipment used in device fabrication, and considerations involved in choosing specific material and/or process for a specific application.

The first two chapters cover the fundamentals of thermal and plasma-assisted CVD, respectively. The discussions of the physics and chemistry are necessarily brief, but cover many of the concepts and models that have been applied to CVD systems. The chapter on plasma-assisted CVD, however, emphasizes the physical and electrical characteristics of the plasma and could be improved by adding a discussion of how this couples to the chemistry of the system. These chapters also introduce the reader to different types of CVD reactors and some of their advantages and disadvantages.

The third and fourth chapters detail processes used for thermal CVD of the most widely used materials: silicon dioxide and nitride, polycrystalline and epitaxial silicon, tungsten, aluminum, and metal silicides. The processes generally used to deposit such films are described, as are the ways these materials are used in microelectronic devices. In addition, considerations such as deposition rates and uniformities, film properties, step coverage, and defects are introduced.

Similar discussions on plasma-assisted CVD processes used to deposit these materials are included in the fifth chapter. Descriptions, photographs and schematics of commercial CVD reactors generally used in production facilities compose chapter six. The last chapter describes a number of the analytical techniques and commercial instruments used to evaluate the properties of deposited films.

The book is useful as a text for introductory courses in microelectronics processing or, in general, for novices to CVD. It is especially appropriate for people who want a general overview before starting an in-depth study of CVD. It can serve as an entry point to the literature, but is not a comprehensive review of existing work.

This book is equipment oriented, making it appropriate for readers who will be working in a production environment. However, the commercial reactors used for production are constantly changing, so parts of the book may become dated. The book would also benefit from a more careful job of editing and proofreading.

Reviewer: Pauline Ho is a member of the technical staff at Sandia National Laboratories in Albuquerque, New Mexico. For the last few years, she has been doing research in fundamental mechanisms of CVD.

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