Shock Waves for Industrial Applications

Edited by L.E. Murr
(Noyes Publications, 1988), approximately 528 pages
ISBN: 0-8155-1170-1

This book is aimed at manufacturers and managers of technology for whom shock-wave methods might provide novel fabrication approaches. The book is also meant as a reference for practicing scientists, engineers, and students. The book contains material on industrial applications, results of recent research, and reviews of basic principles and phenomenology. Topics include shock hardening and strengthening; explosive forming, welding, and cladding; shock compaction and consolidation of powders; and shock sensitization and synthesis. Metals and alloys, ceramics, polymers, and composites are considered. The book contains 13 chapters, six written by the editor and his co-workers. The seven other chapters were written by researchers from various countries.

The book shows that the advantages of shock compression are (1) heterogeneous rapid heating, bonding, and quenching at interfaces and (2) the generation of high densities of dislocations and other defects in bulk, which can alter physical properties in attractive ways. The main advantages for manufacturing are (1) simple, versatile, and relatively inexpensive preforms and tooling, especially for work pieces too large for processing by static presses and (2) the ability to produce laminates of materials with substantially different physical properties. These considerations have meant that shock-wave technology has been devoted primarily to producing specialty items with limited production. In the United States this work is done by a few small companies and by contract research institutions.

The first case of the development of an explosive forming machine for production in volume is described in the chapter by H. Steinicke. More than 300,000 automobile axles have been produced in West Germany with this machine. Capabilities in explosive welding are described in chapters by N.V. Naumovich et al. and D.G. Brasher et al. Control of the interface by inhibiting the formation of brittle interfacial intermetallic compounds is one topic of current emphasis.

Chapters by Murr and Staudhammer and by Meyers and Thadhani discuss general principles and results of explosive powder compaction of engineering materials. The main problems discussed with respect to industrial applications are difficulties in producing near-net non-simple shapes and residual cracking in brittle materials.

Roman and Gorobtsov provide an overview of shock-wave powder compaction and trends in the U.S.S.R. Shock processing is being used to address long-term materials issues. Products developed over the past few years include porous Ti filters, large solid Ti sheets produced by explosive compaction of Ti "sponge," soft ferrites with complex shape and improved magnetic properties, high-temperature cermets, and piezoceramics. (Shock-wave technology has undergone substantial industrial development in the Soviet Union compared to other countries. Thus, this might be a useful area to consider for development of commercial links between the Soviet Union and Western countries.)

A. Sawaoka describes shock compaction results with powders of SiC and cubic-BN. He is addressing residual cracking by using shock-induced exothermic reactions to provide high temperatures *in situ.* The result is a SiC microstructure with substantially fewer cracks. The near-term goal is improved cutting tools; the long-term goal is ceramic heat engine components.

T. Blazynski discusses work in the shock compaction of polymers, pure and composite. Dynamic compaction offers a way to increase compressive strengths and to control electrical and thermal properties.

This book covers a wide range of topics and aims which diffuses its impact and focus. Nevertheless, for those interested in a broad-brush description of the field, it is interesting reading.

Reviewer: William J. Nellis is head of the Shock Compression Group at Lawrence Livermore National Laboratory. His research interests include shock compaction and synthesis and the properties of condensed matter at high shock pressures and temperatures.

Supplementary Volume I: Encyclopedia of Materials Science and Engineering

Edited by Robert W. Cahn
(Pergamon Press and MIT Press, 1988), 653 pages
ISBN: 0-262-03142-6 (v.1) (MIT Press)
0-08-032521-1 (Pergamon Press)

The *Encyclopedia of Materials Science and Engineering* was originally issued as an eight-volume set in 1986. This impressive encyclopedia was designed to set forth the scope and scale of work on the subject, including the synthesis of materials, measurements and predictions of their properties, their commercial fabrication and utilization, and public policy issues associated with all these activities. The scope was bounded by limiting the coverage to durable (as opposed to consumable) materials. Fuels, foodstuffs, and drugs were not considered. Otherwise, the editors of this set attempted to catalog and survey the entire spectrum of activities which comprise the multidisciplinary field of materials science and engineering.

Supplementary Volume I of this encyclopedia is the first of a planned series of supplements designed to update and expand the contents of the original eight-volume main encyclopedia. It was prepared by a new editor, Robert W. Cahn, with the editor-in-chief of the initial volumes, Michael B. Bever, assuming the role of senior advisory editor. Most of the 113 articles in the first supplementary volume constitute expansions in scope of the coverage. A few are replacement articles (e.g., the contribution on "dental implants") or are updates of articles in the initial volumes (e.g., that on "electrically conducting polymers"). All are written in the same format as the original ones, and all cross-reference the contents of the first eight volumes. Two indexes (citation and subject) are provided, but these pertain to Supplementary Volume I alone. A "systematic outline" of the encyclopedia, given in Volume 8, is used as the basis to classify articles in Supplementary Volume I, which also contains an addendum to the original outline.

The articles in this volume are written for readers versed in the concepts and nomenclature of materials science and engineering. Technical terms, mathematical and chemical formulae are common. Therefore, the volume, like the main encyclopedia, is perhaps most useful as a point of entry into the literature for practitioners with at least a bachelor's level technical degree in chemistry, physics, or materials science.

This volume is designed for use in conjunction with the main encyclopedia. Thus, it should be added to the collection of those institutions and individuals which purchased the original eight volumes. Its utility as a stand-alone addition to a personal collection is probably limited to those who possess a special interest in one or more of the topics of the longer articles in the volume.

Reviewer: Charles B. Duke is senior research fellow of the Xerox Corporate Research Group. He has managed and contributed to numerous materials science and engineering projects, and was instrumental in establishing the Molecular Science Research Center at the DOE Pacific Northwest Laboratory.

Laser Microfabrication: Thin Film Processes and Lithography

Edited by Daniel J. Ehrlich and Jeffrey Y. Tsao
(Academic Press, 1989), 587 pages
ISBN: 0-12-233430-2

Laser Microfabrication is an impressive volume detailing the expanding field of laser-assisted patterned chemical processing of surfaces. This interdisciplinary field requires knowledge in materials science, chemistry, laser technology, thin film processing, and microelectronics; each is well covered in this volume.

The book is divided into three parts, covering the technology, fundamentals, and reactions in laser microfabrication. These three parts are further subdivided into ten chapters written by well-known contributors to the field. Most chapters are written in a tutorial or a literature review format. In most instances a broad view of current work and understanding is given, though in a few chapters the authors' own work is heavily emphasized. The book is well organized and edited, and for the most part, the chapters are not repetitive. The emphasis throughout is on basic processes and demonstrated examples, and not on applications.

Chapter 1, which describes the laser technology used in laser surface processing, forms the first part of this volume. The fundamentals of coherent and incoherent light sources are covered, including the basics of lasers commonly used in processing and the nonlinear optical methods used to extend the frequency range of these sources. Relevant optical theory and experimental methods used in direct laser writing and laser projection lithography are then presented in some detail. Researchers with little background with lasers should be able to follow much of the discussion. Those well versed in lasers will appreciate the level of detail.

The second part consists of four chapters on the fundamental physics and chemistry in laser-assisted microfabrication. Chapter 2 is a wide-ranging discussion of laser-stimulated molecular processes on surfaces from the viewpoint of a surface scientist. After a presentation on the mechanisms of laser excitation of solids, adsorbates and gas-phase species, the processes of surface adsorption, reaction, relaxation, and desorption are detailed. Chapter 3 presents the spectroscopy and photochemistry of gases, adsorbates and liquids commonly used in laser surface microchemistry. This chapter is an extremely valuable resource of spectra and literature citations. Though texts on photochemistry often include spectra of some of the relevant reactant molecules, this chapter is definitely more valuable to those interested in laser surface processing because it is current and includes virtually all molecules of interest. Chapter 4 presents the basic physics of laser absorption in solids usually used in laser microfabrication, such as semiconductors and metals, and discusses the physical consequences of laser absorption, such as the creation of electron-hole pairs in semiconductors and heating. Many valuable tables and figures detailing the optical and thermal properties of these materials are provided. Chapter 5, the last in the fundamentals section, discusses the importance of gas-phase and surface mass transport in the kinetics of direct laser writing. This chapter closely follows the very detailed work of the authors in this area.

The last part of this volume consists of five chapters on specific examples of localized and nonlocalized laser-initiated surface reactions. Though these chapters survey essentially all topics of interest, they represent varying levels of completeness as literature reviews. The basic chemical mechanisms are discussed, when known. Chapter 6 presents large area and localized etching of semiconductors, insulators, and metals with lasers. Chapters 7 - 9 each deal with laser-assisted deposition. Though Chapter 7 is arranged according to deposition mechanism and concentrates more on kinetics, while Chapter 8 is arranged according to material type and concentrates more on chemical mechanisms, there is significant overlap between these two chapters. Chapter 9 is relatively distinct in that it concerns only photoepitaxy. Chapter 10 discusses laser-assisted doping of semiconductors and oxidation of semiconductors and metals. Though this third part of the volume gives an excellent survey of laser-assisted chemical processing, the reader is advised to consult even more recent review articles to keep up with new developments.

This volume would be a valuable addition to the library of any researcher in laser-assisted microfabrication. It would also serve as an excellent introduction to the field for those with minimal background in lasers, thin-film processing, and lithography.

Reviewer: Irving P. Herman is an associate professor of applied physics at Columbia University. His interests include laser chemical processing of surfaces, laser spectroscopy of semiconductors, and applications of lasers in materials processing, including isotope separation. □

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