Laser Microfabrication: Thin Film Processes and Lithography

Edited by Daniel J. Ehrlich and Jeffrey Y. Tsao

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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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