

Edited by
Koji Sugioka
Ya Cheng

ULTRAFAST LASER PROCESSING

From Micro- to Nanoscale



Ultrafast Laser Processing From Micro To Nanoscale

TD Snyder



Ultrafast Laser Processing From Micro To Nanoscale:

Ultrafast Laser Processing Koji Sugioka, Ya Cheng, 2013-06-24 Over the past few decades the rapid development of ultrafast lasers such as femtosecond lasers and picosecond lasers has opened up new avenues for material processing due to their unique features such as ultrashort pulse width and extremely high peak intensity These techniques have become a common tool for micro and nanoprocessing of a variety Handbook of Laser Micro- and Nano-Engineering Koji Sugioka, 2021-11-13 This handbook provides a comprehensive review of the entire field of laser micro and nano processing including not only a detailed introduction to individual laser processing techniques but also the fundamentals of laser matter interaction and lasers optics equipment diagnostics as well as monitoring and measurement techniques for laser processing Consisting of 11 sections each composed of 4 to 6 chapters written by leading experts in the relevant field Each main part of the handbook is supervised by its own part editor s so that high quality content as well as completeness are assured The book provides essential scientific and technical information to researchers and engineers already working in the field as well as students and young scientists planning to work in the area in the future Lasers found application in materials processing practically since their invention in 1960 and are currently used widely in manufacturing The main driving force behind this fact is that the lasers can provide unique solutions in material processing with high quality high efficiency high flexibility high resolution versatility and low environmental load Macro processing based on thermal process using infrared lasers such as CO₂ lasers has been the mainstream in the early stages while research and development of micro and nano processing are becoming increasingly more active as short wavelength and or short pulse width lasers have been developed In particular recent advances in ultrafast lasers have opened up a new avenue to laser material processing due to the capabilities of ultrahigh precision micro and nanofabrication of diverse materials This handbook is the first book covering the basics the state of the art and important applications of the dynamic and rapidly expanding discipline of laser micro and nanoengineering This comprehensive source makes readers familiar with a broad spectrum of approaches to solve all relevant problems in science and technology This handbook is the ultimate desk reference for all people working in the field

Pulsed Laser Processing of Electronic Materials in Micro/nanoscale David Jen Hwang, 2005 *Ultrafast Laser Nanostructuring* Razvan Stoian, Jörn Bonse, 2023-04-06 Bringing together contributions from leading experts in the field this book reviews laser processing concepts that allow the structuring of material beyond optical limits and methods that facilitate direct observation of the underlying mechanisms by exploring direct structuring and self organization phenomena The capacity to nanostructure material using ultrafast lasers lays the groundwork for the next generation of flexible and precise material processing tools Rapid access to scales of 100 nm and below in two and three dimensions becomes a factor of paramount importance to engineer materials and to design innovative functions To reflect the dynamic nature of the field at all levels from basic science to applications the book is divided into three parts Fundamental Processes Concepts of

Extreme Nanostructuring and Applications each of which is comprehensively covered This book will be a useful resource for graduate students and researchers in laser processing materials engineering and nanoscience Laser-Surface Interactions for New Materials Production Antonio Miotello, Paolo Ossi, 2009-12-05 This book provides an overview on nanosecond and ultra short laser induced phenomena and the related diagnostics It grew from the lectures of the International School Laser surface interactions for new materials production held in July 2008 **Understanding of the Formation of Micro/nanoscale Structures on Metal Surfaces by Ultrafast Pulse Laser Processing** Edwin Peng, 2017 In the recent decades there has been much interest in functionalized surfaces produced by ultrafast laser processing Using pulse lasers with nanosecond to femtosecond time scale a wide range of micro nanoscale structures can be produced on virtually all metal surfaces These surface structures create special optoelectronic wetting and tribological properties with a diverse range of potential applications Laser Precision Microfabrication Koji Sugioka, Michel Meunier, Alberto Piqué, 2010-08-13 Miniaturization and high precision are rapidly becoming a requirement for many industrial processes and products As a result there is greater interest in the use of laser microfabrication technology to achieve these goals This book composed of 16 chapters covers all the topics of laser precision processing from fundamental aspects to industrial applications to both inorganic and biological materials It reviews the state of the art of research and technological development in the area of laser processing *Nanostructured Biomaterials for Regenerative Medicine* Vincenzo Guarino, Michele Iafisco, Silvia Spriano, 2019-10-05 Nanostructured Biomaterials for Regenerative Medicine focuses on the definition of new trends for the design of biomaterials for biomedical applications It includes the ex novo synthesis as well as technological strategies to manipulate them into appropriate two dimensional 2D and three dimensional 3D forms in order to impart all the main physical chemical structural and biological properties requested to achieve desired clinical efficacy This book aims at offering a concise overview of innovative platforms based on nanostructured biomaterials as a function of their chemical nature established by a consolidated material classification i e polymer ceramics and metals For each class emerging bioinspired systems with rapid expansion in the biomedical research area and fabricated via new enabling technologies will be proposed for the use in tissue repair regeneration and nanomedicine This book is an essential resource for researchers academics and professionals interested in the potential of nanostructured biomaterials for regenerative medicine Classifies materials into three classes for comprehensive discussion Discusses design techniques to create innovative nanostructured biomaterials Looks at enabling technologies and strategies for emerging applications **Macro- to Microscale Heat Transfer** D. Y. Tzou, 2014-09-18 Physical processes taking place in micro nanoscale strongly depend on the material types and can be very complicated Known approaches include kinetic theory and quantum mechanics non equilibrium and irreversible thermodynamics molecular dynamics and or fractal theory and fraction model Due to innately different physical bases employed different approaches may involve different physical properties in describing micro nanoscale heat transport

In addition the parameters involved in different approaches may not be mutually inclusive Macro to Microscale Heat Transfer The Lagging Behavior Second Edition continues the well received concept of thermal lagging through the revolutionary approach that focuses on the finite times required to complete the various physical processes in micro nanoscale Different physical processes in heat mass transport imply different delay times which are common regardless of the material type The delay times termed phase lags are characteristics of materials Therefore the dual phase lag model developed is able to describe eleven heat transfer models from macro to nanoscale in the same framework of thermal lagging Recent extensions included are the lagging behavior in mass transport as well as the nonlocal behavior in space bearing the same merit of thermal lagging in time in shrinking the ultrafast response down to the nanoscale Key features Takes a unified approach describing heat and mass transport from macro micro to nanoscale Compares experimental results for model validation Includes easy to follow mathematical formulation Accompanied by a website hosting supporting material Macro to Microscale Heat Transfer The Lagging Behavior Second Edition is a comprehensive reference for researchers and practitioners and graduate students in mechanical aerospace biological and chemical engineering *High-power Laser Ablation*, 2004 3D Laser Microfabrication Hiroaki Misawa, Saulius Juodkazis, 2006-09-14 A thorough introduction to 3D laser microfabrication technology leading readers from the fundamentals and theory to its various potent applications such as the generation of tiny objects or three dimensional structures within the bulk of transparent materials The book also presents new theoretical material on dielectric breakdown allowing a better understanding of the differences between optical damage on surfaces and inside the bulk as well as a look into the future Chemists physicists materials scientists and engineers will find this a valuable source of interdisciplinary knowledge in the field of laser optics and nanotechnology

Micro and Nanoscale Laser Processing of Hard Brittle Materials Jiwang Yan, Nozomi Takayama, 2019-11-12 Micro and Nanoscale Laser Processing of Hard Brittle Materials examines general laser material interactions within this type of material focusing on the nanoprocessing technologies that these phenomena have given rise to Sections cover laser machining healing recovery sintering surface modification texturing and microstructuring These technologies all benefit from the characteristics of laser processing its highly localized heating ability and its well defined optical properties The book also describes frontier applications of the developed technologies thus further emphasizing the possibility of processing hard brittle materials into complex structures with functional surfaces at both the micro and nanoscale Provides readers with a solid understanding of laser material interactions Helps readers choose suitable laser parameters for processing hard brittle materials Demonstrates how micro and nanoscale laser processing can be used to machine brittle materials without fracture

Laser Micro-Nano-Manufacturing and 3D Microprinting Anming Hu, 2020-11-28 This book provides a comprehensive overview of the latest advances in laser techniques for micro nano manufacturing and an in depth analysis of applications such as 3D printing and nanojoining Lasers have gained increasing significance as a precise tool for advanced manufacturing

Written by world leading scientists the first part of the book presents the fundamentals of laser interaction with materials at the micro and nanoscale including multiphoton excitation and nonthermal melting and allows readers to better understand advanced processing In the second part the authors focus on various advanced fabrications such as laser peening surface nanoengineering and plasmonic heating Finally case studies are devoted to special applications such as 3D printing microfluidics devices energy devices and plasmonic and photonic waveguides This book integrates both theoretical and experimental analysis The combination of tutorial chapters and concentrated case studies will be critically attractive to undergraduate and graduate students researchers and engineers in the relevant fields Readers will grasp the full picture of the application of laser for micro nanomanufacturing and 3D printing

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Femtosecond Laser Material Processing for Micro-/nano-scale Fabrication and Biomedical Applications Hae Woon Choi,2007 Femtosecond laser ablation has interesting characteristics for micromachining notably non thermal interaction with materials high peak intensity precision and flexibility In this dissertation the potential of femtosecond laser ablation for fabrication of biomedical and electronic devices is studied In a preliminary background discussion some key literature regarding the basic physics and mechanisms that govern ultrafast laser pulse interaction with conductive materials and dielectric materials are summarized In the dissertation work results from systematic experiments were used characterize laser ablation of ITO Indium Tin Oxide stainless steel hot embossing applications polymers PMMA PDMS PET and PCL glass and fused quartz Measured parameters and results include ablation threshold damage threshold surface roughness single and multiple pulse ablation shapes and ablation efficiency In addition to solid material femtosecond laser light interaction with electrospun nano fiber fiber mesh was analyzed and studied by optical property measurements Ablation of channels in nano fiber mesh was studied experimentally Internal channel fabrication in glass and PMMA polymers was also demonstrated and studied experimentally In summary it is concluded that femtosecond laser ablation is a useful process for micromachining of materials to produce microfluidic channels commonly needed in biomedical devices such as micro molecular magnetic separators and DNA stretching micro arrays The surface roughness of ablated materials was found to be the primary issue for femtosecond laser fabrication of microfluid channels Improved surface quality of channels by surface coating with HEMA polymer was demonstrated **Proceedings of the 2003 ASME Summer Heat Transfer Conference** ,2003

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