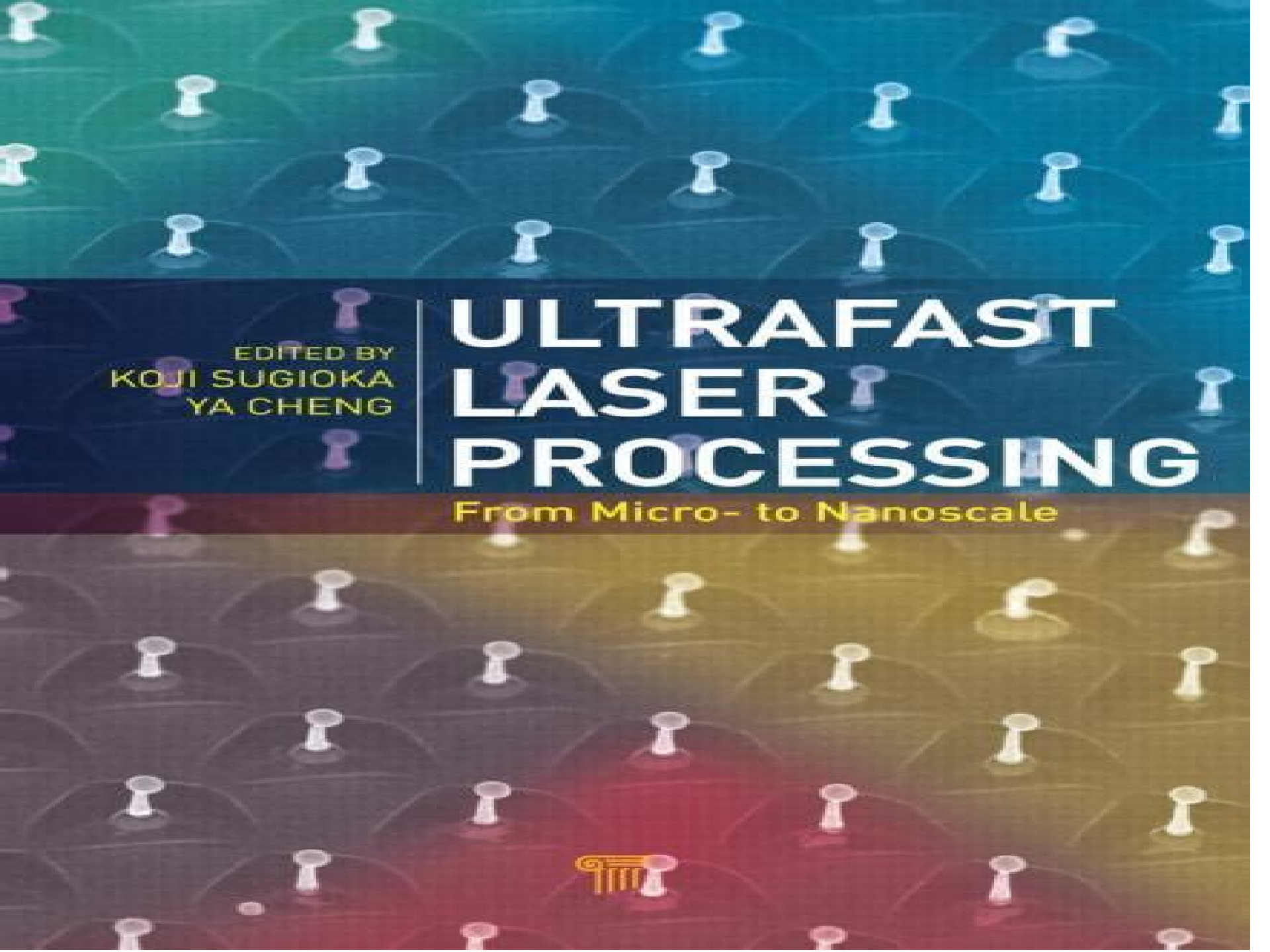
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Ultrafast Laser Processing From Micro To Nanoscale 2013 06 24

Jiwang Yan,Nozomi Takayama

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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 Lasers in Materials Science Marta Castillejo,Paolo M. Ossi,Leonid Zhigilei,2014-01-08 This book covers various aspects of lasers in materials science including a comprehensive overview on basic principles of laser materials interactions and applications enabled by pulsed laser systems The material is organized in a coherent way providing the reader with a harmonic architecture While systematically covering the major current and emerging areas of lasers processing applications the Volume provides examples of targeted modification of material properties achieved through careful control of the processing conditions and laser irradiation parameters Special emphasis is placed on specific strategies aimed at nanoscale control of material structure and properties to match the stringent requirements of modern applications Laser fabrication of novel nanomaterials which expands to the domains of photonics photovoltaics sensing and biomedical applications is also discussed in the Volume This book assembles chapters based on lectures delivered at the Venice International School on Lasers in Materials Science which was held in Isola di San Servolo Venice Italy in July 2012

Optically Induced Nanostructures Karsten König,Andreas Ostendorf,2015-05-19 Nanostructuring of materials is a task at the heart of many modern disciplines in mechanical engineering as well as optics electronics and the life sciences This book includes an introduction to the relevant nonlinear optical processes associated with very short laser pulses for the generation of structures far below the classical optical diffraction limit of about 200 nanometers as well as coverage of state of the art technical and biomedical applications These applications include silicon and glass wafer processing production of nanowires laser transfection and cell reprogramming optical cleaning surface treatments of implants nanowires 3D nanoprinting STED lithography friction modification and integrated optics The book highlights also the use of modern femtosecond laser microscopes and nanoscopes as novel nanoprocessing tools Encyclopedia of Interfacial Chemistry ,2018-03-29 Encyclopedia of Interfacial Chemistry Surface Science and Electrochemistry Seven Volume Set summarizes current fundamental knowledge of interfacial chemistry bringing readers the latest developments in the field As the chemical and

physical properties and processes at solid and liquid interfaces are the scientific basis of so many technologies which enhance our lives and create new opportunities its important to highlight how these technologies enable the design and optimization of functional materials for heterogeneous and electro catalysts in food production pollution control energy conversion and storage medical applications requiring biocompatibility drug delivery and more This book provides an interdisciplinary view that lies at the intersection of these fields Presents fundamental knowledge of interfacial chemistry surface science and electrochemistry and provides cutting edge research from academics and practitioners across various fields and global regions **Advances in Tribology** Pranav H. Darji,2016-10-26 In the major field of design and manufacturing of mechanical production automobile and industrial engineering typical and advance methodologies and processes are implemented for the best performance of product or machinery Thus the concept of tribology has come into practice for even better performance Nowadays it is very important that the tribological knowledge be implemented at each stage of design and manufacturing to minimize the frictional and wear losses and ultimately these will serve as best preference for the economical growth of the nation Currently tribologists are playing vital role in the same direction This book contains original and innovative research studies on recent applications of tribology contributed by the group of selected researchers describing the best of their work Through its 11 chapters the reader will have access to work in 3 major areas of tribology These are surface engineering and coating friction and wear mechanism and lubrication technology The first part of the book from Chapters 1 to 4 deals with the surface treatment and coating through which component life can be improved by reducing wear rate The second part of the book from Chapters 5 to 7 deals with tribo testing and tribo system monitoring for friction and wear mechanism presented with real life case studies The third part from Chapters 8 to 11 discusses the advances in lubrication which also includes the role of nanolubricants and lubrication additives This book may be of interest to research scholars academicians industrialists professional engineers and specialists in these related areas and would also be of immense help to various practicing engineers technologists managers and supervisors engaged in the maintenance operation and upkeep of different machines equipments systems and plants of various industries *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 Silicon Based MEMS Materials and Technologies** Markku Tilli,Mervi Paulasto-Kröckel,Teruaki Motooka,Veikko Lindroos,2015-09-02 The Handbook of Silicon Based MEMS Materials and Technologies Second Edition is a comprehensive guide to MEMS materials technologies and manufacturing that examines the state of the art with a particular emphasis on silicon as the most important starting material used in MEMS The book explains the fundamentals properties mechanical electrostatic optical etc materials selection preparation manufacturing

processing system integration measurement and materials characterization techniques sensors and multi scale modeling methods of MEMS structures silicon crystals and wafers also covering micromachining technologies in MEMS and encapsulation of MEMS components Furthermore it provides vital packaging technologies and process knowledge for silicon direct bonding anodic bonding glass frit bonding and related techniques shows how to protect devices from the environment and provides tactics to decrease package size for a dramatic reduction in costs Provides vital packaging technologies and process knowledge for silicon direct bonding anodic bonding glass frit bonding and related techniques Shows how to protect devices from the environment and decrease package size for a dramatic reduction in packaging costs Discusses properties preparation and growth of silicon crystals and wafers Explains the many properties mechanical electrostatic optical etc manufacturing processing measuring including focused beam techniques and multiscale modeling methods of MEMS structures Geared towards practical applications rather than theory **Preparation and Application of Intelligent Bioactive Nanocolloids** Yu Luo,Xin Li,Andrij Pich,Bo Yin,2023-12-29 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

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 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 *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 **Pulsed Laser Processing of Electronic Materials in Micro/nanoscale** David Jen Hwang,2005 Parallel Diffractive Multi-beam Ultrafast Laser Micro-processing Zheng Kuang,2010

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 **Parallel Diffractive Multi-Beam Ultrafast Laser Microprocessing** Zheng Kuang,2012-06 Ultrafast lasers have been widely employed for material micro nano processing with little thermal damage Due to the ultra high intensity of ultrashort pulses nonlinear absorption can be induced at the focus leading to highly localised material ablation or modification This is now opening up applications ranging from integrated optics through multi photon induced refractive index engineering to precision surface micro structuring To ensure the non thermal processing input pulse energy must be kept around micro joule level However running at kilohertz repetition rate many ultrafast laser systems can provide milli joule level output Therefore significant energy attenuation causes a great deal of energy loss With this limitation in mind a multi beam ultrafast laser processing where the milli joule output is split into many desired diffracted beams is proposed in this book The multi beam patterns are generated by phase modulation through a Spatial Light Modulator SLM and can be applied in real time with synchronized scanning methods The results demonstrate high precision parallel ultrafast laser micro nano fabrication with greatly increased efficiency and throughput **Ultrafast Laser Fabrication of Hybrid Micro- and Nano- Structures in Semiconductor-doped Borosilicate Glasses** Pavel Mardilovich,2012 With increasing interest in fs laser based photonic device fabrication and mesoscale composite materials the goal of the project was to produce hybrid micro nano structure via ultrafast laser modification of semiconductor doped glass SDG combined with a possible second processing step of heat treatment at elevated temperatures The aim was to induce precipitation of the dopant semiconductor in micron scale regions defined by fs laser processing Photoinduced chemical changes were monitored with electron microscopy and wave dispersive x ray spectroscopy WDS meanwhile the development of optically active features was monitored with confocal fluorescence spectroscopy in combination with optical microscopy 3 laser systems were tested each for a range of parameters 800 nm 1 kHz repetition rate 200 fs pulse width Ti Sapphire Spectra Physics laser 1030 nm 1 MHz repetition rate 750 fs pulse width Uranus series PolarOnyx fiber laser 1030 nm 473 kHz rep rate 750 fs pulse width unknown model PolarOnyx fiber laser The SDG substrate was Schott s OG570 re

melted to dissolve the semiconductor into a homogeneous solution The fs laser processed samples were heat treated at temperatures in the 500 C 600 C range 1 kHz laser has proven to be unsuitable for space selective semiconductor precipitation in the chosen SDG The work discusses some of the reasons that contribute to this negative result suggesting that the trend would extend to other SDGs Lines written with the two high repetition rate lasers 1 MHz and 473 kHz have shown elemental segregation that exhibits consistent behavior over a wide processing parameter window The elements diffuse away from the laser focal volume to form a pattern 10 150 mu m in size of three chemically distinct zones Zn rich Si rich and Na and K rich arranged in that order at an increasing distance from the modifying beam Heat treating the fs laser processed samples resulted in evolution of fluorescence at the Na and K rich region Two peaks were observed in the spectra a red peak and a blue peak The red peak was a broad peak centered at 710 nm and did not change position with heat treatment It appeared in the early stages of the heat treatment and then disappeared as the blue peak emerged The blue peak initially appeared as a partial peak near the 473 nm pump line then becoming a full peak as it shifted its position towards longer wavelengths with continued heat treatment The moving blue peak is assigned to near band edge electron hole recombination in the CdS subscript x Se subscript 1 x nanocrystals and is held as evidence of semiconductor precipitation in the photomodified glass The location of the peak changes as the particles grow at an elevated temperature and degree of quantum confinement diminishes The stationary 710 nm peak is attributed to Se2 formation and its disappearance is tied to consumption of selenium as semiconductor nanocrystals nucleate and grow A model for this spatially selective semiconductor precipitation behavior is suggested on the basis of glass transition dependence on network modifier concentration It is posited that increase in a local concentration of sodium and potassium effectively forms a micro crucible with lower glass transition temperature and increased local network mobility sufficient to result in faster semiconductor precipitation dynamics as compared to the surrounding bulk glass The contributions from local solubility and semiconductor concentration changes are also discussed but at present there is limited information to fully account for the extent of these contributions Overall the method of introducing chemical segregation with high repetition rate laser and then exploiting the localized increases in network mobility is shown to be a very robust method for controlled space selective semiconductor precipitation With some further development steps suggested this processing method can prove a powerful tool in photonic device fabrication **Laser Micro/nano Machining Based on Spatial, Temporal and Spectral Control of Light-matter Interaction** Xiaoming Yu,2016 Lasers have been widely used as a manufacturing tool for material processing such as drilling cutting welding and surface texturing Compared to traditional manufacturing methods laser based material processing is high precision can treat a wide range of materials and has no tool wear However demanding manufacturing processes emerging from the needs of nano and 3D fabrication require the development of laser processing strategies that can address critical issues such as machining resolution processing speed and product quality This dissertation concerns the

development of novel laser processing strategies based on spatial temporal and spectral control of light matter interaction In the spatial domain beam shaping is employed in ultrafast laser micro processing Zero order Bessel beam generated by an axicon is used for selective removal of the back contact layer of thin film solar cells Bessel beam s propagation invariance property gives rise to an extension of focal range by orders of magnitude compared to Gaussian beam greatly increasing process tolerance to surface unevenness and positioning error Together with the axicon a spatial light modulator is subsequently used to modify the phase of laser beam and generate superpositions of high order Bessel beam with high energy efficiency With the superposed beam processing speed can be increased significantly and collateral damage resulting from the ring structures in the zero order Bessel beam can be greatly suppressed In the temporal domain it is demonstrated that ionization in dielectric materials can be controlled with a pair of ultraviolet and infrared pulses With the assistance of the long wavelength infrared pulse nano scale features are achieved using only a small fraction of threshold energy for the short wavelength pulse Computer simulation based on the rate equation model is conducted and found to be in good agreement with experimental results This study paves the way for future adoption of short wavelength laser sources for example in the extreme ultraviolet range for direct laser nano fabrication with below threshold pulse energy In the spectral domain a short wavelength infrared laser is used to generate modification in the bulk of silicon wafers in an attempt to develop 3D fabrication capabilities in semiconductors Issues such as spherical aberration correction and examination procedure are addressed Permanent modification is generated inside silicon by tightly focusing and continuously scanning the laser beam inside the samples without introducing surface damage The effect of laser pulse energy and polarization is also investigated These results demonstrate the potential of controlling laser processing in multiple dimensions for manufacturing purposes and point to a future when laser can be used as naturally and efficiently as mechanical tools used today but is targeted at more challenging problems Ultrafast Lasers for Materials Science Michael J. Kelly,2005 Kelley Jefferson Lab US Kreutz U of Technology Aachen Germany Li Panasonic Boston Laboratory US and Pique Naval Research Laboratory US present 29 papers from the November December 2004 Materials Research Society symposium of the same name organized with the goal of bringing together researchers exploring the use of ultrafast lasers for materials synthesis processing and analysis The sessions of the symposium covered fundamental science and technology of ultrafast lasers materials characterization laser ablation and deposition micromachining and nanostructuring synthesis of nanoparticles and nanowiries and direct writing of waveguides in transparent materials Specific topics selected from the ten invited papers include phase change mechanisms in pulsed laser matter interaction high power THz generation form sub ps bunches of relativistic electrons micro and nano structured optical fibers as artificial media for amplification of light modification and color markings in glasses by UV laser radiation and generation of new nanomaterials by interfering femtosecond laser processing Annotation 2005 Book News Inc Portland OR booknews com Industrial Applications of Ultrafast Lasers

Richard Haight,Adra V. Carr,2017-05-31 This book describes the application of ultrafast laser science and technology in materials and processing relevant to industry today including ultrafast laser ablation where fundamental studies have led to the development of the world s first femtosecond photomask repair tool Semiconductor manufacturing companies worldwide use the tool to repair photomask defects saving hundreds of millions in production costs The most up to date ultrafast laser technologies are described and methods to generate high harmonics for photoelectron spectroscopy of industrially important materials are covered with an emphasis on practical laboratory implementation Basic device physics merged with photoemission studies from single and polycrystalline materials are described Extensions to new methods for extracting key device properties of metal oxide semiconductor structures including band offsets effective work functions semiconductor band bending and defect related charging in a number of technologically important gate oxides are detailed Polycrystalline photovoltaic materials and heterostructures as well as organic light emitting materials are covered This book describes both the history and most recent applications of ultrafast laser science to industrially relevant materials processes and devices

Decoding **Ultrafast Laser Processing From Micro To Nanoscale 2013 06 24**: Revealing the Captivating Potential of Verbal Expression

In a period characterized by interconnectedness and an insatiable thirst for knowledge, the captivating potential of verbal expression has emerged as a formidable force. Its capability to evoke sentiments, stimulate introspection, and incite profound transformations is genuinely awe-inspiring. Within the pages of "**Ultrafast Laser Processing From Micro To Nanoscale 2013 06 24**," a mesmerizing literary creation penned by way of a celebrated wordsmith, readers attempt an enlightening odyssey, unraveling the intricate significance of language and its enduring effect on our lives. In this appraisal, we shall explore the book is central themes, evaluate its distinctive writing style, and gauge its pervasive influence on the hearts and minds of its readership.

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