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Femtosecond Laser-Matter Interaction: Theory, Experiments ...

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femtosecond laser matter interaction theory experiments femtosecond laser matter interaction has already found numerous applications in this is the first comprehensive treatment of the interaction of femtosecond laser pulses with solids at nonrelativistic intensity it connects generation of extreme pressure and temperature in the interaction

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and applications femtosecond laser matter interaction theory experiments and the femtosecond laser matter interaction has already found numerous applications in industry medicine and materials science however there is no consensus on the interpretation of related phenomena with mathematics kept to a minimum this is a highly engaging

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This is the first comprehensive treatment of the interaction of femtosecond laser pulses with solids at nonrelativistic intensity. It connects phenomena from the subtle atomic motion on the nanoscale to the generation of extreme pressure and temperature in the interaction zone confined inside a solid. The femtosecond laser-matter interaction has al

This book discusses aspects of laser pulses generation, characterization, and practical applications. Some new achievements in theory, experiments, and design are demonstrated. The introductive chapter shortly overviews the physical principles of pulsed lasers operation with pulse durations from seconds to yoctoseconds. A theory of mode-locking, based on the optical noise concept, is discussed. With this approximation, all paradoxes of ultrashort laser pulse formation have been explained. The book includes examples of very delicate laser operation in biomedical areas and extremely high power systems used for material processing and water purification. We hope this book will be useful for engineers and managers, for professors and students, and for those who are interested in laser science and technologies.

Femtosecond optics involves the study of ultra-short pulses of light. Understanding the behaviour of these light pulses makes it possible to develop ultra-fast lasers with a wide range of applications in such areas as medical imaging, chemical analysis and micro-machining. Written by two leading experts in the field, this book reviews the theory of the interaction of femtosecond light pulses with matter, femtosecond lasers and laser systems, and the principles of femtosecond coherent spectroscopy of impurity amorphous media. reviews the theory of the interaction of femtosecond light pulses with matter Discusses femtosecond lasers and laser systems Considers the principles of femtosecond coherent spectroscopy of impurity amorphous media

The revised edition of this important reference volume presents an expanded overview of the analytical and numerical approaches employed when exploring and developing modern laser materials processing techniques. The book shows how general principles can be used to obtain insight into laser processes, whether derived from fundamental physical theory or from direct observation of experimental results. The book gives readers an understanding of the strengths and limitations of simple numerical and analytical models that can then be used as the starting-point for more elaborate models of specific practical, theoretical or commercial value. Following an introduction to the mathematical formulation of some relevant classes of physical ideas, the core of the book consists of chapters addressing key applications in detail: cutting, keyhole welding, drilling, arc and hybrid laser-arc welding, hardening, cladding and forming. The second edition includes a new a chapter on glass cutting with lasers, as employed in the display industry. A further addition is a chapter on meta-modelling, whose purpose is to construct fast, simple and reliable models based on appropriate sources of information. It then makes it easy to explore data visually and is a convenient interactive tool for scientists to improve the quality of their models and for developers when designing their processes. As in the first edition, the book ends with an updated introduction to comprehensive numerical simulation. Although the book focuses on laser interactions with materials, many of the principles and methods explored can be applied to thermal modelling in a variety of different fields and at different power levels. It is aimed principally however at academic and industrial researchers and developers in the field of laser technology.

This volume offers theoretical investigations of atoms and molecules interacting with pulsed or continuous wave lasers. Theoretical background is included, and the text incorporates several exercises. Additional calculations are performed in the appendices.

This book succinctly describes the ultra-short laser-matter interactions from the subtle atomic motion under the gentle excitation up to the generation of extreme pressures by the beam tightly focussed inside the bulk of a transparent crystal. It is the fully rewritten successor to Femtosecond Laser-Matter Interactions: Theory, Experiment and Applications (2011). Explanation and experimental verification of the exceptional technique for the phase transformations under extreme pressure are in the core of the book. The novel phase formation occurs along the unique solid-plasma-solid transformation path: The memory of the initial state is lost after conversion to plasma, and the restructuring proceeds during the cooling of the confined plasma. The extreme-pressure-affected material remains detained inside a pristine crystal at the laboratory tabletop. The super-dense aluminium and the previously unobserved crystalline phases of silicon were created by this method of confined micro-explosions. Recent studies have used the quasi-non-diffracting Bessel beams for increasing the number of new phases. The applications comprise the new material formation at extreme conditions and micromachining. The book is an engaging literature for readers interested in the cutting-edge research on the extreme energy density generation at the laboratory tabletop.

Expensive, delicate, and difficult to operate, femtosecond lasers have already won two Nobel Prizes and created multi-billion dollar industries. As these lasers break out of laboratories for use in real-world large-scale applications, the number of people using them increases. This book provides a fresh perspective on femtosecond lasers, discussing how they are soon to become a universal light source, spanning any timescale and generating any wavelength of light. Starting from the basics of light itself, this book presents in an everyday manner, with clear illustrations and without formulas, what makes this class of lasers so versatile and the future of many more applications. Many of the subjects covered in this book are described in plain words for the first time.

Femtosecond Physics: Laser-Matter Interaction Theory examines various theories related to femtosecond physics including an extensive overview of interaction theory and related concepts. It includes definitions of time-dependent schrödinger equation, field-matter interaction in quantum two-level systems and atoms and molecules. Provides the reader with insights into the development of its knowledge, so as to understand the different theories and applications of femtosecond physics.

This book represents the first comprehensive treatment of the subject, covering the theoretical principles, present experimental status and important applications of short-pulse laser-matter interactions.Femtosecond lasers have undergone dramatic technological advances over the last fifteen years, generating a whole host of new research activities under the theme of “ultrafast science”. The focused light from these devices is so intense that ordinary matter is torn apart within a few laser cycles. This book takes a close-up look at the exotic physical phenomena which arise as a result of this new form of “light-matter” interaction, covering a diverse set of topics including multiphoton ionization, rapid heatwaves, fast particle generation and relativistic self-channeling. These processes are central to a number of exciting new applications in other fields, such as microholography, optical particle accelerators and photonuclear physics.Repository for numerical models described in Chapter 6 can be found at www.fz-juelich.de/zam/cams/plasma/SPLIM/./a

This book deals with the Laser-Induced Breakdown Spectroscopy (LIBS) a widely used atomic emission spectroscopy technique for elemental analysis of materials. It is based on the use of a high-power, short pulse laser excitation. The book is divided into two main sections: the first one concerning theoretical aspects of the technique, the second one describing the state of the art in applications of the technique in different scientific/technological areas. Numerous examples of state of the art applications provide the readers an almost complete scenario of the LIBS technique. The LIBS theoretical aspects are reviewed. The book helps the readers who are less familiar with the technique to understand the basic principles. Numerous examples of state of the art applications give an almost complete scenario of the LIBS technique potentiality. These examples of applications may have a strong impact on future industrial utilization. The authors made important contributions to the development of this field.