Non Linear Optical Properties Of Semiconductors Iopscience

For design purposes one needs to relate the structure of proposed materials to their NLO (nonlinear optical) and other properties, which is a situation where theoretical approaches can be very helpful in providing suggestions for candidate systems that subsequently can be synthesized and studied experimentally. This brief describes the quantum-mechanical treatment of the response to one or more external oscillating electric fields for molecular and macroscopic, crystalline systems. To calculate NLO properties of large systems, a linear scaling generalized elongation method for the efficient and accurate calculation is introduced. The reader should be aware that this treatment is particularly feasible for complicated three-dimensional and/or delocalized systems that are intractable when applied to conventional or other linear scaling methods.

Nonlinear Optical Properties of Organic Molecules and Crystals, Volume 1 discusses the nonlinear optical effects in organic molecules and crystals, providing a classical distinction between quadratic and cubic processes. This book begins with a general overview of the basic properties of organic matter, followed by a review on the benefits derived from quantum-chemistry-based models and growth and characterization of high quality, bulk organic crystals and waveguided structures. A case study focusing on a specific material, namely urea, which exemplifies a situation in which transparency in the UV region has been purposely traded for nonlinear efficiency is also deliberated. This text concludes with a description of a type of trade-off between the unpredictable orientation of molecules in crystalline media, polarity of liquid-crystalline structures, and dominant electronic contribution to the electro-optic effect. This publication is beneficial to solid-state physicists and chemists concerned with nonlinear optical properties of organic molecules and crystals.

In this work optical properties of two dimensional quantum well structures are studied. Variational calculation of the eigenstates in an isolated quantum well structure with and without the external electrical field is presented. At weak fields a quadratic Stark shift is found whose magnitude depends strongly on the finite well depth. It is observed that under external electrical field, the asymmetries due to lack of inversion symmetry leads to higher order nonlinear optical effects such as second order optical polarization and second order optical susceptibility.

Nonlinear Optical Properties of Organic Molecules and Crystals, Volume 2 deals with the nonlinear optical properties of organic molecules and crystals, with emphasis on cubic nonlinear optical effects and and the intermolecular bond. Topics covered include the basic structural and electronic properties of polydiacetylenes; cubic effects in polydiacetylene solutions and films; and degenerate third-order nonlinear optical susceptibility of polydiacetylenes. Dimensionality effects and scaling laws in nonlinear optical susceptibilities are also considered. This volume is comprised of seven chapters divided into two sections and begins with a discussion on the basic structural and electronic properties of polydiacetylenes as well as their methods of preparation. Cubic nonlinearities in polydiacetylene solutions and films are then examined, paying particular attention to polarization in one-dimensional media; multiple reflections of fundamental and harmonic waves; and harmonic generation in an absorbing medium. The following chapters focus on degenerate third-order nonlinear optical susceptibility of polydiacetylenes; dimensionality effects and scaling laws in nonlinear optical susceptibilities; polarizabilities and hyperpolarizabilities of long molecules; and resonant molecular optics. The final chapter analyzes the nonlinear optics of a wide range of compounds that are held together by intermolecular bonding and form supramolecular assemblies. This monograph will be a useful resource for physicists, physical and organic chemists, and those in the field of quantum electronics.

Organic Nonlinear Optical Materials provides an extensive description of the preparation and characterization of organic materials for applications in nonlinear and electro-optics. The book discusses the fundamental optimization and practical limitations of a number of figures of merit for various optical parameters and gives a clinical appraisal of the potential of organic materials for applicators in optical technology. Among the topics addressed are the basic molecular design of ;nonlinear optical chromophores, fundamentals and novel techniques of organic crystal growth, preparation and characterization of Langmuir-Blodgett and polymer films, experimental methods for determining microscopic and macroscopic optical properties. Also included is a discussion of first results of the photorefractive effect in organic crystals and the potential of organics for photorefractive applications, as well as an extensive review of published linear and nonlinear optical measurement of organic materials.

In this thesis, a comprehensive analytical and numerical study of optical non-linear effects in plasmonic metamaterials is presented. The new results reported and described in this work can potentially have a significant impact on our understanding of electromagnetic phenomena in artificial optical materials, and facilitate the design and fabrication of new active optical devices with new or enhanced functionality. Equally important, these results could lead to deeper physical insights into the fundamental properties of these metamaterials. To this end, a new analytical formalism based on the multiple scattering theory has been developed, a theoretical framework that allows one to fully characterise the linear and non-linear electromagnetic properties of arbitrary distributions of metallic nanowires. This formalism is unique in allowing readily retrieval of the spatial distribution of the electromagnetic field both at the fundamental frequency (linear analysis) and the second harmonic (non-linear optical response). The formalism also allows for both frequency- and time-domain investigations. Based on this work, a new software tool with unique features has been implemented and used to achieve a better understanding of the intricate electromagnetic phenomena occurring in nano-structured plasmonic systems. In particular, this tool has been used to design and investigate numerically several new non-linear plasmonic structures and nanodevices with remarkable properties. Amongst them were non-linear plasmonic cavities with high quality factors, plasmonic cavities that support non-linear whispering gallery modes and sub-wavelength non-linear plasmonic sensors with enhanced sensitivity and reduced device volume. Several other plasmonic systems that show tremendous potential for the development

of advanced metamaterials-based devices have also been explored. Specifically, it was demonstrated that nano-patterned metasurfaces can be employed to achieve polarisation controlled electromagnetic response in arrays of cruciform apertures and magnetisation induced second harmonic generation in chiralmetallic structures. The numerical investigation of photonic superlattices exhibiting zero effective index of refraction has also been discussed.
This book is mostly concerned on the experimental research of the nonlinear optical characteristics of various media, low- and high-order harmonic generation in different materials, and formation, and nonlinear optical characterization of clusters. We also demonstrate the inter-connection between these areas of nonlinear optics. Nonlinear optical properties of media such as optical limiting can be applied in various areas of science and technology. To define suitable materials for these applications, one has to carefully analyse the nonlinear optical characteristics of various media, such as the nonlinear refractive indices, coefficients of nonlinear absorption, saturation absorption intensities, etc. Knowing the nonlinear optical parameters of materials is also important for describing the propagation effects, self-interaction of intense laser pulses, and optimisation of various nonlinear optical processes. Among those processes one can admit the importance of the studies of the frequency conversion of coherent laser sources. The area of interest for nonlinear optical characterization of materials is also closely related with new field of nanostructures formation and application during laser-matter interaction. We show how the nonlinear optical analysis of materials leads to improvement of their high-order nonlinear optical response during the interaction with strong laser fields. Ablation-induced nanoparticles formation is correlated with their applications as efficient sources of coherent short-wavelength photons. From other side, recent achievements of harmonic generation in plasmas are closely related with the knowledge of the properties of materials in the laser plumes. All of these studies are concerned with the low-order nonlinear optical features of various materials. The novelty of the approach developed in present book is related with inter-connection of those studies with each other.
Nonlinear optics is a topic of much current interest that exhibits a great diversity. Some publications on the subject are clearly physics, while others reveal an engineering bias; some appear to be accessible to the chemist, while others may appeal to biological understanding. Yet all purport to be non linear optics so where is the underlying unity? The answer is that the unity lies in the phenomena and the devices that exploit them, while the diversity lies in the materials used to express the phenomena. This book is an attempt to show this unity in diversity by bringing together contributions covering an unusually wide range of materials, preceded by accounts of the main phenomena and important devices. Because ofthe diversity, individual materials are treated in separate chapters by different expert authors, while as editors we have shouldered the task of providing the unifying initial chapters. Most main classes of nonlinear optical solids are treated: semiconductors, glasses, ferroelectrics, molecular crystals, polymers, and Langmuir-Blodgett films. (However, liquid crystals are not covered.) Each class of material is enough for a monograph in itself, and this book is designed to be an introduction suitable for graduate students and those in industry entering the area of nonlinear optics. It is also suitable in parts for final-year undergraduates on project work. It aims to provide a bridge between traditional fields of expertise and the broader field of nonlinear optics.
This report results from a contract tasking Universite de Montpellier II as follows: The contractor will investigate the nonlinear optical properties of a variety of organometallic polymer-based materials. Organic materials offer the potential for greatly increased non-linear interactions with intense laser light, enabling the construction of a wide variety of electro-optic components for laser systems.
In this thesis, a comprehensive analytical and numerical study of optical non-linear effects in plasmonic metamaterials is presented. The new results reported and described in this work

can potentially have a significant impact on our understanding of electromagnetic phenomena in artificial optical materials, and facilitate the design and fabrication of new active optical devices with new or enhanced functionality. Equally important, these results could lead to deeper physical insights into the fundamental properties of these metamaterials. To this end, a new analytical formalism based on the multiple scattering theory has been developed, a theoretical framework that allows one to fully characterise the linear and non-linear electromagnetic properties of arbitrary distributions of metallic nanowires. This formalism is unique in allowing readily retrieval of the spatial distribution of the electromagnetic field both at the fundamental frequency (linear analysis) and the second harmonic (non-linear optical response). The formalism also allows for both frequency- and time-domain investigations. Based on this work, a new software tool with unique features has been implemented and used to achieve a better understanding of the intricate electromagnetic phenomena occurring in nano-structured plasmonic systems. In particular, this tool has been used to design and investigate numerically several new non-linear plasmonic structures and nanodevices with remarkable properties. Amongst them were non-linear plasmonic cavities with high quality factors, plasmonic cavities that support non-linear whispering gallery modes and sub-wavelength non-linear plasmonic sensors with enhanced sensitivity and reduced device volume. Several other plasmonic systems that show tremendous potential for the development of advanced metamaterials-based devices have also been explored. Specifically, it was demonstrated that nano-patterned metasurfaces can be employed to achieve polarisation controlled electromagnetic response in arrays of cruciform apertures and magnetisation induced second harmonic generation in chiral metallic structures. The numerical investigation of photonic superlattices exhibiting zero effective index of refraction has also been discussed.

Nano-photonic structures offer a highly interesting platform to enhance light-matter interaction on a nanometer scale. Recently, high-index dielectric structures have gained increasing attention as possible low-loss alternatives to plasmonic nano-antennas made from noble metals. Furthermore, since non-linear effects offer many unique functionalities like the coherent up-conversion of photons, including the generation of harmonics, many efforts are being made to exploit such phenomena in nano-photonics. In this thesis, an analysis is presented on nonlinear optical effects in individual dielectric structures, specifically in silicon nanowires (SiNWs). Nanowires develop strong optical resonances in the visible and infrared spectral range. In this context, strong enhancement of the optical near-field together with a large surface to volume ratio support the appearance of nonlinear effects. We show that, compared to bulk Si, a two orders of magnitude increase in second harmonic generation (SHG) is feasible and furthermore unravel different polarization and size-dependent contributions at the origin of the SHG. Numerical simulations are carried out to reaffirm these experimental findings for which a numerical technique is presented to describe nonlinear effects on the basis of the Green Dyadic Method (GDM). In the last part of the thesis, the GDM is used together with evolutionary optimization (EO) algorithms to tailor and optimize optical properties of photonic nano-structures. We eventually fabricate samples, based on EO design, and successfully verify the predictions of the optimization algorithm. It turns out that EO is an extremely versatile tool and has a tremendous potential for many kinds of further applications in nano-optics.

This publication represents the proceedings of the Conference on Organic Materials for Non-Linear Optics, held in Oxford in June 1988. It was a truly international conference attended by over 160 delegates from academia, industry and government research establishments, who represented a wide range of scientific disciplines and included organic and organometallic chemists, theorists and experimental physicists and device engineers.

Nonlinear Optical Properties of Organic Molecules and Crystals V1 ...

In recent years, optical properties of the unique atomic and molecular structures of materials have drawn great scientific interest. Linear optical properties of materials such as metals, metal oxides, magnetic oxides, and organic materials are based on energy transfer and find applications in wastewater treatment, forensic science, biomedical science, photovoltaics, nuclear technology, and LED displays. Nonlinear optical properties of materials are based on the nonlinear medium and find more advanced applications in frequency mixing generations and optical parametric oscillations. This book presents the underlying principles, implementation, and applications of the linear and nonlinear optical properties of materials and has been divided into two parts emphasizing these properties. The first part of the book, Linear Optics, discusses bimetallic nanoparticles in dielectric media and their integration to dye molecules to detect trace amounts of heavy metals at the nanometer level, as well as to enhance luminescence and image contrasts in forensic inspection and biomedical diagnosis. It shows how the integration of bimetallic nanoparticles into a ZnO matrix promotes broadening of the absorption spectrum from the ultraviolet to the visible wavelength. It explains the role of surface adsorption and photocatalytic degradation in dye-removal kinetics by Fe3O4 magnetic nanoparticles under pulsed white light. It also discusses the double-layer shielding tank design to safely store radioactive waste and photon propagation through the multilayer structures of a human tissue model. The second part of the book, Nonlinear Optics, presents general concepts such as electromagnetic theory, nonlinear medium, and wave propagation, as well as more advanced concepts such as second harmonic generation, phase matching, optical parametric interactions, different frequency generation, sum frequency generation, tunable laser, and optical resonant oscillator.

This thesis examines the nonlinear optical properties of 14:14 GaAs/AlAs superlattice-core waveguides at wavelengths in the 1550 nm telecommunications range. The linear optical properties of as-grown superlattice show polarization dependencies that are attributed to the difference in the half-bandgap for TE and TM polarizations and the structural anisotropy of the superlattice. Two-photon absorption measurements in as-grown superlattice yielded polarization-dependent coefficients between 1.5 cm/W to 4.0 cm/W, which are larger than in bulk AlGaAs. Spectral broadening induced by self-phase modulation was observed to give nonlinear refraction coefficients n2 of 1.5 cm2/W to 5.5 cm2/W with TE modes having values as much as twice as large as the TM mode. The ratio of self- to cross-phase modulation between polarizations showed a polarization dependence. Intermixing superlattice resulted in a reduction in n2 by one order of magnitude. Figure of merit values show superlattice is a viable material for nonlinear optical devices.

Nonlinear Optics, Fourth Edition, is a tutorial-based introduction to nonlinear optics that is suitable for graduate-level courses in electrical and electronic engineering, and for electronic and computer engineering departments, physics departments, and as a reference for industry practitioners of nonlinear optics. It will appeal to a wide audience of optics, physics and electrical and electronic engineering students, as well as practitioners in related fields, such as materials science and chemistry. Presents an introduction to the entire field of optical physics from the perspective of nonlinear optics Combines first-rate pedagogy with a treatment of the fundamental aspects of nonlinear optics Covers all the latest topics and technology in this ever-evolving industry Contains a strong emphasis on fundamentals

The study of the non-linear optical properties of polymeric systems is a challenging and exciting field of research ranging from device engineering, optical measurements, chemical synthesis to design and theoretical issues. At the present time, most of the basic science needed for the synthesis of molecules and the design of devices utilizing second order optical susceptibilities is in hand, although certain issues remain to be resolved. On the other hand, many important questions regarding the design and use of third order optical susceptibilities are still unanswered. The earliest ideas of the importance of low dimensionality optical band gaps suggests the use of conjugated molecules. At present, there is considerable effort, both experimentally and theoretically, in optimizing the value of gamma for polymers or oligomers with conjugated segments, because such conjugated polymers (like polyacetylene, polythiophenes, and the poly-diacetylenes) have very large gamma. These polymers have also been under intense scrutiny because of their large conductivities when doped. Although we are beginning to understand the theoretical reasons for the various unusual properties of the materials, we do not understand the factors that limit the ultimate value of gamma. For example, what are the important structures and interactions in the molecule the prevent gamma from being as large as possible while still having a small absorption coefficient, and how can we design molecules with these constraints in mind.

The object of the present research is to design and fabricate metal-dielectric thin film multilayer structures that make use of the nonlinear optical (NLO) response of Ag for efficient nonlinear absorption for sensor protection. These structures employ structural resonances to overcome the challenges of reflection and absorption that limit access to this large NLO response. The research consists of three parts: first, we present a comprehensive analysis of the contributions to the nonlinear optical response of Ag. Second, we present a systematic investigation of the linear optical properties of Metal-Dielectric Photonic Band-Gap (MDPBG) structures, including optimization of the structure for a particular transmittance spectrum. Third, we study the linear and nonlinear optical properties of Induced Transmission Filters (ITFs). Each of these parts includes experimental results backed by modeling and simulation.

Metamaterials are materials whose optical properties can be designed through the accurate engineering of their structure on the subwavelength scale. They have enabled the discovery and study of a variety of interesting new optical properties not normally present in materials found in nature. Furthermore, by designing the local electromagnetic field distributions of such metamaterials, it is possible to engineer not only their linear optical properties but also their nonlinear response, which is fundamental for the development of nonlinear and active nanophotonics for all-optical information processing. In this thesis I will show that plasmonic metamaterials based on metallic nanorod arrays can be designed to have strong third-order nonlinear optical response originating from the nonlinearity of the plasmonic component of the metamaterial, allowing nonlinear processes to be more energy efficient and highly integrated. The nonlinearity will be experimentally determined through the z-scan technique and explained by numerical modeling in both effective medium and fullvectorial simulations. Enhancements of about 50 times for the nonlinear absorption and about 10 times for the nonlinear refraction are observed compared to a smooth metal film. Furthermore, the properties of waveguides comprised of the nanorod metamaterial are studied and the possibility of their integration in conventional Si photonic waveguides is demonstrated. In this context, two all-optical modulators using plasmonic metamaterials are designed, operating in the hyperbolic and epsilon near-zero regimes. Both designs are highly integrated and energy efficient having footprints of 300x440x600 nm3 and 300xl80x340 nm3 with an energy consumption of 3.7 pJ/bit and 0.6pJ/bit respectively. The obtained results show great opportunities for nonlinear metamaterials in nanophotonic applications.

This monograph is devoted to a detailed treatment of the nonlinear optical properties of liquid crystals. The basic concepts of director optical reorientation and thermal nonlinearities are presented showing the fundamental theoretical approaches and describing the main experimental observations. The presentation is self-consistent and tutorial although the subject matter is of current research interest.The last part of the book deals with more recent results on new composite materials: Polymer Dispersed Liquid Crystals (PDLC). A general presentation of the optical properties is given and the observations of several nonlinear optical effects are reported.

In this paper, we present the results of our first-principles quantum mechanical studies of the electronic structure, geometry, and linear and nonlinear optical (NLO) properties of tetrahedral GaN atomic clusters. Our calculated results suggest that the linear and NLO properties both exhibit a strong dependence upon cluster size and shape (geometry). However, the size- and the geometry-dependences are more pronounced for the NLO properties than for the linear optical properties. For clusters containing equal numbers of Ga and N atoms, an open-structure with no network-forming ring has a much larger second-order NLO coefficient than a cluster with a closed ring structure.

The quantum well semiconductor laser has been shown to be the semiconductor laser of choice for efficiency and thereby high power applications. The key advantage of nonlinear devices fabricated in quantum well waveguides is that they can be easily integrated with quantum well lasers. Nonlinear optical effects in GaAs/AlGaAs quantum wells have been of considerable interest for sometime. In guided-wave formats some nonlinear devices have been demonstrated; a nonlinear directional coupler has been fabricated and characterised, and a saturable absorber for a mode-locking semiconductor laser has also been demonstrated.

This book assembles both theory and application in this field, to interest experimentalists and theoreticians alike. Part 1 is concerned with the theory and computing of non-linear optical (NLO) properties while Part 2 reviews the latest developments in experimentation. This book will be invaluable to researchers and students in academia and industry, particularlrly to anyone involved in materials science, theoretical and computational chemistry, chemical physics, and molecular physics.

Good,No Highlights,No Markup,all pages are intact, Slight Shelfwear,may have the corners slightly dented, may have slight color changes/slightly damaged spine.