Optical Processes In Semiconductors Pankove

Optical Processes In Semiconductors Pankove Optical processes in semiconductors Pankove are fundamental phenomena that underpin a wide range of modern electronic and optoelectronic devices. Understanding these processes is essential for advancing technologies such as lasers, light-emitting diodes (LEDs), photodetectors, and solar cells. This article provides a comprehensive overview of the key optical mechanisms in semiconductors, with particular reference to the pioneering work of Jacques Pankove, whose research significantly contributed to our understanding of light-matter interactions in these materials. Introduction to Optical Processes in Semiconductors Semiconductors are materials characterized by an energy band structure that allows controlled electrical conductivity. When interacting with electromagnetic radiation, semiconductors exhibit various optical processes that depend on their electronic properties, doping levels, temperature, and structural quality. These processes are crucial for the operation of optoelectronic devices, where the control and manipulation of light within semiconductor materials are required. Fundamental Optical Processes in Semiconductors The primary optical processes in semiconductors can be broadly categorized into absorption, emission, scattering, and nonlinear optical phenomena. Each process involves interactions between photons and the electronic states within the material. 1. Absorption of Light Absorption occurs when photons with energy equal to or greater than the semiconductor's bandgap excite electrons from the valence band to the conduction band. This process is fundamental for photodetectors and solar cells, where photon absorption generates electron-hole pairs for electrical current. Interband Absorption: Electron transition from valence to conduction band across the bandgap. Intraband Absorption: Transitions within the same band, relevant in doped semiconductors. Absorption Coefficient: Quantifies how strongly a material absorbs light at a specific wavelength. Pankove's work emphasized the importance of the absorption coefficient in determining the efficiency of light absorption and the design of optoelectronic devices. 2 2. Spontaneous Emission Spontaneous emission is the process where an excited electron in the conduction band relaxes to a lower energy state, emitting a photon randomly in time and direction. This process is fundamental in light-emitting devices such as LEDs and semiconductor lasers. Radiative Recombination: Electron-hole pairs recombine, emitting photons. Quantum Efficiency: The ratio of emitted photons to recombined electron-hole pairs. Pankove's studies contributed to understanding how material quality and impurity levels influence spontaneous emission rates. 3. Stimulated Emission and Laser Action Stimulated emission occurs when an incident photon stimulates an excited electron-hole pair to recombine, emitting a photon coherent with the incident light. This process forms the basis for semiconductor lasers. Population Inversion: Achieved when more electrons occupy excited states than ground states. Gain Medium: The semiconductor material that amplifies light via stimulated emission. Research inspired by Pankove's work laid the groundwork for understanding threshold conditions and gain spectra in semiconductor lasers. 4. Nonradiative Recombination Nonradiative processes involve energy dissipation as heat rather than light. They include: Auger Recombination: Energy transferred to another electron or hole, leading to thermalization. Shockley-Read-Hall (SRH) Recombination: Via defect or impurity states within the bandgap. Minimizing nonradiative recombination is critical for improving device efficiency, a focus of Pankove's research. 5. Scattering Processes Photon scattering within semiconductors affects optical transparency and coherence. Rayleigh Scattering: Elastic scattering by small particles or fluctuations. Raman Scattering: Inelastic scattering involving phonons, used for material 3 characterization. Understanding scattering mechanisms informs the design of optical components such as waveguides and filters. Nonlinear Optical Phenomena in Semiconductors At high light intensities, semiconductors exhibit nonlinear optical effects, including second-harmonic generation, self-focusing, and two-photon absorption. These phenomena expand the potential applications in optical switching, frequency conversion, and ultrafast photonics. 1. Two-Photon Absorption A nonlinear process where two photons simultaneously excite an electron across the bandgap, enabling access to otherwise inaccessible spectral regions. 2. Harmonic Generation Generation of new frequencies (second, third harmonics) through nonlinear polarization, useful in creating coherent light sources at different wavelengths. Impact of Pankove's Research on Optical Processes Jacques Pankove's pioneering studies in the 1960s and 1970s laid the foundation for understanding the interaction of light with semiconductors. His work elucidated the mechanisms of optical absorption, emission, and the design principles for efficient optoelectronic devices. Key contributions include: Developing models for the optical properties of direct and indirect bandgap semiconductors. Analyzing nonradiative recombination pathways and their effects on device performance. Investigating the impact of impurities and defects on optical processes. Advancing the understanding of the optical gain spectrum in semiconductor lasers. His research continues to influence the development of high-efficiency LEDs, laser diodes, and photovoltaic cells. Applications of Optical Processes in Semiconductors The practical implications of understanding optical processes in semiconductors are vast, including: Light-Emitting Diodes (LEDs): Rely on radiative recombination for efficient light 4 emission. Semiconductor Lasers: Use stimulated emission for coherent light sources in communications, medicine, and manufacturing. Photodetectors and Solar Cells: Depend on absorption processes to convert light into electrical signals or power. Optical Modulators and Switches: Manipulate light via nonlinear effects for high- speed data transmission. Quantum Computing and Communication: Utilize quantum states manipulated through optical interactions. Future Directions in Optical Processes in Semiconductors Advances in material science—such as two-dimensional materials (graphene, transition metal dichalcogenides), nanostructures (quantum dots, nanowires), and novel heterostructures—are opening new avenues for optical processes. Emerging research areas include: Enhanced Nonlinearities: For ultrafast optical switching. Integrated Photonics: Combining semiconductors with silicon photonics for compact devices. Quantum Optics: Exploiting quantum states of light in semiconductor nanostructures for secure communication. Energy Harvesting: Improving photovoltaic efficiency through tailored absorption and emission properties. Continued exploration of optical processes in semiconductors promises to revolutionize technology across telecommunications, computing, and energy sectors. Conclusion Optical processes in semiconductors Pankove encompass a rich and complex set of phenomena that are central to modern optoelectronics. From fundamental absorption and emission mechanisms to advanced nonlinear effects, these processes enable the development of devices that have transformed everyday life. Pankove’s groundbreaking research provided critical insights that continue to inform current innovations. As new materials and nanostructures emerge, understanding and harnessing these optical interactions will remain at the forefront of scientific and technological progress. QuestionAnswer 5 What are the key optical processes in semiconductors discussed by Pankove? Pankove's work highlights processes such as absorption, emission, recombination, and scattering of light within semiconductors, which are fundamental to understanding their optoelectronic behavior. How does Pankove describe the role of intrinsic and extrinsic defects in optical processes? Pankove explains that defects can act as recombination centers or trap states, significantly affecting optical absorption and emission properties in semiconductors. What is the significance of excitons in the optical processes of semiconductors according to Pankove? Pankove emphasizes that excitons, which are bound electron-hole pairs, play a crucial role in optical absorption and emission, especially near the band edge in semiconductors. How does Pankove's theory address the phenomenon of photoluminescence in semiconductors? Pankove describes photoluminescence as the radiative recombination of electrons and holes, providing insights into the material's purity, defect states, and electronic structure. What insights does Pankove provide about the impact of temperature on optical processes in semiconductors? Pankove discusses how increasing temperature can influence carrier recombination rates, phonon interactions, and the broadening of spectral lines, affecting optical efficiency. In Pankove's work, how are optical absorption spectra used to characterize semiconductors? Absorption spectra reveal information about the bandgap, defect states, and excitonic features, allowing for detailed analysis of the electronic structure of semiconductors. What are the practical applications of understanding optical processes in semiconductors as outlined in Pankove's research? Applications include designing efficient photodetectors, light-emitting diodes, laser devices, and solar cells by optimizing their optical properties based on fundamental processes. How does Pankove's treatment of optical processes advance the development of semiconductor optoelectronic devices? His detailed understanding of optical interactions enables better material engineering, leading to improved device performance, efficiency, and new functionalities in optoelectronics. Optical processes in semiconductors Pankove have long been a subject of intense research and technological importance, underpinning the development of a wide array of optoelectronic devices such as lasers, light-emitting diodes (LEDs), photodetectors, and solar cells. The foundational work by Jacques Pankove and colleagues laid the groundwork for understanding how semiconductors interact with light at a fundamental level. This article provides a comprehensive review of the optical phenomena in semiconductors, with a particular focus on the theoretical frameworks, experimental observations, and technological implications stemming from Pankove’s contributions. --- Optical Processes In Semiconductors Pankove 6 Introduction to Optical Processes in Semiconductors Semiconductors are materials with electrical conductivity between conductors and insulators, characterized by a bandgap that enables a rich variety of optical interactions. When photons interact with semiconductors, they can induce electronic transitions, leading to phenomena such as absorption, emission, scattering, and nonlinear effects. Understanding these processes is crucial for optimizing the performance of optoelectronic devices. The optical processes in semiconductors are governed by their electronic band structure, phonon interactions, impurity states, and many-body effects. Pankove’s pioneering work emphasized the importance of excitonic effects, radiative and non- radiative recombination, and optical gain mechanisms, providing a comprehensive framework for analyzing these phenomena. --- Fundamental Optical Processes Absorption and Interband Transitions Absorption in semiconductors primarily involves the promotion of electrons from the valence band to the conduction band when the photon energy exceeds the bandgap energy (Eg). This process is fundamental to devices like photodetectors and solar cells. - Direct vs. Indirect Bandgap Absorption: - In direct bandgap semiconductors (e.g., GaAs), electrons can transition directly from valence to conduction band with photon absorption, leading to strong optical absorption near the band edge. - In indirect bandgap materials (e.g., silicon), phonon participation is required for momentum conservation, resulting in weaker absorption and more complex spectra. - Spectral Dependence: - The absorption coefficient (⊠) near the band edge follows the Tauc relation, with a square root dependence for direct gaps and a more complex behavior for indirect gaps. Excitons: Bound Electron-Hole Pairs One of Pankove's significant contributions was elucidating the role of excitons—hydrogen- like bound states of electrons and holes—in optical processes. - Formation: - Excitons form when an electron-hole pair, generated by photon absorption, remains Coulombically bound before recombining or dissociating. - Types of Excitons: - Wannier-Mott excitons: Large radius, prevalent in materials with high dielectric constants. - Frenkel excitons: Small radius, typical in molecular crystals. - Optical Signatures: - Exciton absorption peaks appear as sharp lines below the bandgap energy, significantly influencing the optical spectra. - Implications: - Excitonic effects enhance optical absorption and emission efficiency, especially at low temperatures, and are essential considerations in quantum well and quantum dot devices. Optical Processes In Semiconductors Pankove 7 Radiative and Non-Radiative Recombination Recombination processes dictate the efficiency of light emission and energy conversion in semiconductors. - Radiative Recombination: - Electron-hole pairs recombine emitting photons, forming the basis of LEDs and laser diodes. - The radiative recombination rate is influenced by factors such as exciton binding energy, carrier densities, and temperature. - Non-Radiative Recombination: - Processes like Shockley-Read-Hall (defect-mediated) and Auger recombination dissipate energy as heat, reducing emission efficiency. - Pankove emphasized the importance of material quality and defect states in controlling non- radiative pathways. --- Optical Gain and Laser Action in Semiconductors The realization of semiconductor lasers hinges on achieving optical gain through population inversion and stimulated emission. Population Inversion and Gain Mechanisms - Population Inversion: - Achieved by electrical injection or optical pumping, leading to a higher population of electrons in the conduction band than in the valence band. - Optical Gain Coefficient: - Quantifies the amplification of light within the medium. - Dependent on the carrier density, temperature, and the joint density of states. - Threshold Conditions: - The gain must overcome intrinsic and mirror losses for lasing to occur. Role of Excitons in Gain Spectra Pankove’s studies showed that excitonic effects can lead to sharp features in the gain spectrum, potentially lowering lasing thresholds and enabling devices operating at lower energies. Design Considerations for Semiconducting Lasers - Material quality, waveguide design, and cavity quality factor (Q) are critical. - Quantum well structures exploit quantum confinement to enhance gain and reduce threshold currents. --- Photoluminescence and Electroluminescence These processes are vital for characterizing materials and developing light-emitting devices. Photoluminescence (PL) - Principle: - Optical excitation creates electron-hole pairs that recombine radiatively, Optical Processes In Semiconductors Pankove 8 emitting photons. - Insights from PL: - Reveals information about band structure, impurity levels, excitonic properties, and defect states. - Temperature-dependent PL studies elucidate exciton binding energies and non-radiative processes. Electroluminescence (EL) - Principle: - Electrical injection of carriers leads to radiative recombination and light emission. - Applications: - Basis for LEDs and display technologies. - Efficiency Considerations: - Pankove highlighted the importance of minimizing non-radiative pathways and optimizing carrier injection for high quantum efficiency. --- Nonlinear Optical Effects in Semiconductors Advanced applications exploit nonlinear interactions such as second-harmonic generation, self-focusing, and optical bistability. - Mechanisms: - Intensity-dependent refractive index changes (Kerr effect). - Two-photon absorption processes. - Relevance: - Nonlinear effects enable ultrafast switching, frequency conversion, and optical modulation. - Material Considerations: - Wide-bandgap semiconductors like GaN and ZnO exhibit strong nonlinear responses suitable for integrated photonics. --- Technological Implications and Future Directions The understanding of optical processes in semiconductors, as advanced by Pankove and subsequent researchers, continues to drive innovation in several fields: - Optoelectronic Devices: - High-efficiency LEDs, laser diodes, and photodetectors. - Solar cells with optimized absorption and carrier collection. - Quantum Optics and Nanostructures: - Quantum dots, wells, and wires exploit excitonic effects for novel light sources. - Integrated Photonics: - Semiconductor materials are central to developing compact, high- speed optical communication systems. - Emerging Materials: - Two-dimensional semiconductors like transition metal dichalcogenides (TMDCs) exhibit unique optical properties rooted in their excitonic and many-body interactions, building upon foundational concepts established by Pankove. --- Conclusion The comprehensive exploration of optical processes in semiconductors, from fundamental absorption and emission mechanisms to complex nonlinear effects, reflects a rich interplay of quantum mechanics, material science, and device engineering. Jacques Pankove’s pioneering research has profoundly shaped our understanding of these phenomena, establishing principles that continue to influence modern optoelectronics. As the field advances, leveraging these insights will be critical in designing next-generation devices with enhanced efficiency, new functionalities, and integration into broader technological systems. Understanding these processes not only illuminates the Optical Processes In Semiconductors Pankove 9 fundamental physics but also opens pathways for innovation across telecommunications, energy, and information processing sectors. The ongoing investigation into excitonic effects, carrier dynamics, and nonlinear interactions promises to yield transformative technologies rooted in the core principles elucidated by Pankove and his contemporaries. semiconductors, Pankove, optical absorption, photoluminescence, excitons, bandgap, impurity states, recombination, optical properties, Pankove theory

Optical Processes in SemiconductorsHydrogen in Semiconductors IINonlinear Optics in Semiconductors IUltrafast Physical Processes in SemiconductorsIII-Nitride SemiconductorsDefect Engineering in Semiconductor Growth, Processing, and Device TechnologyShallow Impurity Centers in SemiconductorsPhysics and Applications of Dilute NitridesSemiconductors and SemimetalsShallow Impurities in Semiconductors, Proceedings of the 3rd INT Conference on Shallow Impurities in Semiconductors Held at Linkoping, Sweden, 10-12 August 1988Frontal Semiconductor ResearchSemiconductors and SemimetalsNitride Semiconductors: Volume 482Compound SemiconductorProceedings of the ... International Autumn Meeting Gettering and Defect Engineering in Semiconductor TechnologyProgress in SemiconductorsAmorphous Semiconductors for MicroelectronicsGallium Nitride and Related Materials: Volume 395Defects in Semiconductors Icds-18Hydrogen in Semiconductors Jacques I. Pankove M.O. Manasreh S. Ashok A. Baldereschi I. Buyanova Jacques I. Pankove Bo Monemar Oliver T. Chang Robert K. Willardson Materials Research Society. Meeting Alan F. Gibson David Adler R. D. Dupuis Masashi Suezawa Norbert H. Nickel

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comprehensive text and reference covers all phenomena involving light in semiconductors emphasizing modern applications in semiconductor lasers electroluminescence photodetectors photoconductors photoemitters polarization effects absorption spectroscopy more numerous problems 339 illustrations since its inception in 1966 the series of numbered volumes known as semiconductors and semimetals has distinguished itself through the careful selection of well known authors editors and contributors the willardson and beer series as it is widely known has succeeded in publishing numerous landmark volumes and chapters not only did many of these volumes make an impact at the time of their publication but they continue to be well cited years after their original release recently professor eicke r weber of the university of california at berkeley joined as a co editor of the series professor weber a well known expert in the field of semiconductor materials will further contribute to continuing the series tradition of publishing timely highly relevant and long impacting volumes some of the recent volumes such as hydrogen in semiconductors imperfections in iii v materials epitaxial microstructures high speed heterostructure devices oxygen in silicon and others promise that this tradition will be maintained and even expanded reflecting the truly interdisciplinary nature of the field that the series covers the volumes in semiconductors and semimetals have been and will continue to be of great interest to physicists chemists materials scientists and device engineers in modern industry provides the most in depth coverage of hydrogen in silicon available in a single source includes an extensive chapter on the neutralization of defects in iii b1v semiconductors combines both experimental and theoretical studies to form a comprehensive reference

since its inception in 1966 the series of numbered volumes known as semiconductors and semimetals has distinguished itself through the careful selection of well known authors editors and contributors the willardson and beer series as it is widely known has succeeded in publishing numerous landmark volumes and chapters not only did many of these volumes make an impact at the time of their publication but they continue to be well cited years after their original release recently professor eicke r weber of the university of california at berkeley joined as a co editor of the series professor weber a well known expert in the field of semiconductor materials will further contribute to continuing the series tradition of publishing timely highly relevant and long impacting volumes some of the recent volumes such as hydrogen in semiconductors imperfections in iii v materials epitaxial microstructures high speed heterostructure devices oxygen in silicon and others promise that this tradition will be maintained and even expanded reflecting the truly interdisciplinary nature of the field that the series covers the volumes in semiconductors and semimetals have been and will continue to be of great interest to physicists chemists materials scientists and device engineers in modern industry

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research advances in iii nitride semiconductor materials and device have led to an exponential increase in activity directed towards electronic and optoelectronic applications there is also great scientific interest in this class of materials because they appear to form the first semiconductor system in which extended defects do not severely affect the optical properties of devices the volume consists of chapters written by a number of leading researchers in nitride materials and device technology with the emphasis on the dopants incorporations impurities identifications defects engineering defects characterization ion implantation irradiation induced defects residual stress structural defects and phonon confinement this unique volume provides a comprehensive review and introduction of defects and structural properties of gan and related compounds for newcomers to the field and stimulus to further advances for experienced researchers given the current level of interest and research activity directed towards nitride materials and devices the publication of the volume is particularly timely early pioneering work by pankove and co workers in the 1970s yielded a metal insulator semiconductor gan light emitting diode led but the difficulty of producing p type gan precluded much further effort the current level of activity in nitride semiconductors was inspired largely by the results of akasaki and co workers and of nakamura and co workers in the late 1980s and early 1990s in the development of p type doping in gan and the demonstration of nitride based leds at visible wavelengths these advances were followed by the successful fabrication and commercialization of nitride blue laser diodes by nakamura et al at nichia the chapters contained in this volume constitutes a mere sampling of the broad range of research on nitride semiconductor materials and defect issues currently being pursued in academic government and industrial laboratories worldwide

proceedings of the san francisco meeting of april may 1992 papers emphasize deliberate and controlled introduction and manipulation of defects in order to engineer some desired properties in semiconductor materials and devices topics include defects in bulk crystals and in thin films defect characterization hydrogen interaction processing induction of defects quantum wells ion implantation annotation copyright by book news inc portland or

shallow impurity centers in semiconductors presents the proceedings of the second international conference on shallow impurity centers fourth trieste iupap ictp semiconductor symposium held at the international center for theoretical physics in trieste italy on july 28 to august 1 1986 the book presents the perspectives of some of the leading scientists in the field who address basic physical aspects and device implications novel phenomena recent experimental and theoretical techniques and the behavior of impurities in new semiconductor materials organized into 22 chapters the book begins with an overview of the early years of shallow impurity states before turning to a discussion of progress in spectroscopy of shallow centers in semiconductors since 1960 it then looks at theoretical and experimental aspects of hydrogen diffusion and shallow impurity passivation in semiconductors along with optical excitation spectroscopy of isolated double donors in silicon the book methodically walks the reader through recent research on double acceptors using near mid and far infrared spectroscopy the far infrared absorption spectrum of elemental shallow donors and acceptors in germanium and impurity spectra in stress induced uniaxial germanium using zeeman spectroscopy other papers focus on the theoretical properties of hydrogenic impurities in quantum wells lattice relaxations at substitutional impurities in semiconductors shallow bound excitons in silver halides and the electronic structure of bound excitons in semiconductors the book concludes with a chapter that reviews picosecond spectroscopy experiments performed in iii v compounds and alloy semiconductors this volume will be useful to physicists and researchers who are working on shallow impurity centers in semiconductor physics

since their development in the 1990s it has been discovered that diluted nitrides have intriguing properties that are not only distinct from those of conventional semiconductor materials but also are conducive to various applications in optoelectronics and photonics the book examines these applications and presents a broad and in depth look at t shallow impurities in semiconductors well established as the backbone of semiconductor applications in electronics continue to play an important role in today s research the third international conference on shallow impurities in semiconductors was organised to critically review some of the recent and current developments with emphasis given to certain topics these included shallow impurities in quantum structures silicon and germanium thermal donors and related defects in silicon dx centres in iii v compounds hydrogen passivation and diffusion of shallow impurities shallow impurities in semiconductors 1988 brings together selected papers from this conference both invited and contributed a broad range of physical phenomena related to shallow impurities in a large number of semiconductor materials are included these proceedings should be of wide interest both in the physics community and in the broad engineering field of microelectronics

this book includes within its scope studies of the structural electrical optical and acoustical properties of bulk low dimensional and amorphous semiconductors computational semiconductor physics interface properties including the physics and chemistry of heterojunctions metal semiconductor and insulator semiconductor junctions all multi layered structures involving semiconductor components dopant incorporation growth and preparation of materials including both epitaxial e g molecular beam and chemical vapour methods and bulk techniques in situ monitoring of epitaxial growth processes also included are appropriate aspects of surface science such as the influence of growth kinetics and chemical processing on layer and device properties the physics of semiconductor electronic and optoelectronic devices are examined including theoretical modelling and experimental demonstration all aspects of the technology of semiconductor device and circuit fabrication relevant areas of molecular electronics and semiconductor structures incorporating langmuir blodgett films resists lithography and metallisation where they are concerned with the definition of small geometry structure the structural electrical and optical characterisation of materials and device structures are also included the scope encompasses materials and device reliability reliability evaluation of technologies failure analysis and advanced analysis techniques such as sem e beam optical emission microscopy acoustic microscopy techniques liquid crystal techniques noise measurement reliability prediction and simulation reliability indicators failure mechanisms including charge migration trapping oxide breakdown hot carrier effects electro migration stress migration package related failure mechanisms effects of operational and environmental stresses on reliability

this book is on recent experimental and theoretical progress in the rapidly growing field of iii v nitrides issues related to crystal growth bulk and thin films structure and microstructure formation of defects doping alloying formation of heterostructures determination of physical properties and device fabrication and evaluation are addressed papers show much progress in the growth and understanding of iii v nitrides and in the production of optoelectronic devices based on these materials most exciting is the fact that light emitting diodes and laser diodes have now reached amazing levels of performance which forecasts a revolution in lighting optical storage printing and display technologies topics include crystal growth bulk growth early stages of epitaxy crystal growth mocvd growth techniques mbe and hvpe novel substrates and growth techniques structural properties electronic properties luminescence and recombination characterization elemental and stress analysis physical modelling device processing implantation annealing device characterization contacts degradation and injection laser diodes and applications

this book reflects the excitement in the scientific community about iii v nitrides based on papers presented at the first international symposium on gallium nitride and related materials isgn 1 it reveals the large amount of work that has taken place since the field exploded with the announcement of commercial blue light emitting devices the compound semiconductors in the iii v nitride systems are of increasing interest for high performance optoelectronic and electronic device applications these wide bandgap semiconductor materials are also of great fundamental scientific interest because of their unique structural electrical and optical properties from the advances in the technologies for the heteroepitaxial growth of these materials leading to improved quality and device performance it is expected that iii v nitrides will soon be of significant practical and commercial interest topics include crystal growth substrates and early stages molecular beam growth techniques chemical vapor phase and alloys and novel growth techniques structural properties electronic properties optical properties point defects hydrogen etching and other materials processes surfaces and metal contacts and devices

the study of defects in semiconductors has never been independent of the progress in semiconductor technology with rapid development in semiconductor device technology novel types of defects as well as very peculiar behavior of defects in semiconductors have been found one after another new subjects in the basic study of defects have often been arisen from experiences in the practical field great progress has also been achieved in device production technology on the basis of the knowledge clarified in the basic field

the study of hydrogen in solids is of significant importance in modern technology often present in large concentrations by various growth techniques hydrogen affects the structural electronic and optical properties of crystals isolated hydrogen is often electrically active causing passivation or charge compensation of defects and impurities since the presidential proposal of the freedom car hydrogen in semiconductors takes another twist as a potential source of clean fuel for the future the study of hydrogen transport diffusion and chemical reaction in solids is therefore of significant social importance but as often happens in science different groups of researchers studying hydrogen in solids do not always speak the same language for example few people would consider silicon as a practical fuel storage material due to its weight but in reality aluminum hydrides have been seriously considered for such a purpose the knowledge acquired in the last half century for hydrogen in conventional semiconductors has not been effectively transferred to the study of hydrogen storage in emerging semiconductors such as carbon nanotubes this volume brings together scientists from various research areas to encourage cross fertilization and wider dissemination of the advances in this important field of study highlights include recent developments in the understanding of light induced metastability in amorphous silicon hydrogen in zinc oxide as a means of n type doping and hydrogen doping of dilute nitrides that modifies the bandgap in some rather surprising ways hydrogen interaction with donors and acceptors is a never ending story that is also featured here topics include hydrogen in elemental semiconductors hydrogen in oxides and general properties of hydrogen in semiconductors

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