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 Hierarchical Micro/Nanostructured Materials: Fabrication, Properties, and Applications presents the latest fabrication, properties, and applications of hierarchical micro/nanostructured materials in two sections—powders and arrays. After a general introduction to hierarchical micro/nanostructured materials, the first section begins with a detailed

The use of copper, silver, gold and platinum in jewelry as a measure of wealth is well known. This book contains 19 chapters written by international authors on other uses and applications of noble and precious metals (copper, silver, gold, platinum, palladium, iridium, osmium, rhodium, ruthenium, and rhenium). The topics covered include surface-enhanced Raman scattering, quantum dots, synthesis and properties of nanostructures, and its applications in the diverse fields such as high-tech engineering, nanotechnology, catalysis, and biomedical applications. The basis for these applications is their high-free electron concentrations combined with high-temperature stability and corrosion resistance and methods developed for synthesizing nanostructures. Recent developments in all these areas with up-to-date references are emphasized.

This book presents the latest results of quantum properties of light in the nanostructured environment supporting surface plasmons, including waveguide quantum electrodynamics, quantum emitters, strong-coupling phenomena and lasing in plasmonic structures. Different approaches are described for controlling the emission and propagation of light with extreme light confinement and field enhancement provided by surface plasmons. Recent progress is reviewed in both experimental and theoretical investigations within quantum plasmonics, elucidating the fundamental physical phenomena involved and discussing the realization of quantum-controlled devices, including single-photon sources, transistors and ultra-compact circuitry at the nanoscale.

The must-have ten-volume successor to the critically acclaimed Nanotechnologies for the Life Sciences series, Nanomaterials for the Life Sciences, 10 Volume Set provides an excellent, in-depth overview of all nanomaterial types and their uses in the life sciences. Each volume is dedicated to a specific material class and covers fundamentals, synthesis strategies, structure-property relationships, material behavior fine-tuning, biological effects, and applications in the life sciences. This landmark set provides materials scientists, chemists, biologists, molecular biologists, clinical physicists, physiological chemists, medicinal chemists, and toxicologists with essential
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This book discusses the early stages of the development of nanostructures, including synthesis techniques, growth mechanisms, the physics and chemistry of nanostructured materials, various innovative characterization techniques, the need for functionalization and different functionalization methods as well as the various properties of nanostructured materials. It focuses on the applications of nanostructured materials, such as mechanical applications, nanoelectronics and microelectronic devices, nano-optics, nanophotonics and nano-optoelectronics, as well as piezoelectric, agriculture, biomedical and, environmental remediation applications, and anti-microbial and antibacterial properties. Further, it includes a chapter on nanomaterial research developments, highlighting work on the life-cycle analysis of nanostructured materials and toxicity aspects.

Nanostructured materials is one of the hottest and fastest growing areas in today's materials science field, along with the related field of solid state physics. Nanostructured materials and their based technologies have opened up exciting new possibilites for future applications in a number of areas including aerospace, automotive, x-ray technology, batteries, sensors, color imaging, printing, computer chips, medical implants, pharmacy, and cosmetics. The ability to change properties on the atomic level promises a revolution in many realms of science and technology. Thus, this book details the high level of activity and significant findings are available for those involved in research and development in the field. It also covers industrial findings and corporate support. This five-volume set summarizes fundamentals of nano-science in a comprehensive way. The contributors enlisted by the editor are at elite institutions worldwide. Key Features * Provides comprehensive coverage of the dominant technology of the 21st century * Written by 127 authors from 16 countries, making this truly international * First and only reference to cover all aspects of nanostructured materials and nanotechnology

This book gives an overview of nanostructures and nanomaterials applied in the fields of energy and organic electronics. It combines the knowledge from advanced deposition and processing methods of nanomaterials such as laser-based growth and nanopatterning and state-of-the-art characterization techniques with special emphasis on the optical, electrical, morphological, surface and mechanical properties. Furthermore it contains theoretical and experimental aspects for different types of nanomaterials such as nanoparticles, nanotubes and thin films for organic electronics applications. The international group of authors specifically chosen for their distinguished expertise belong to the academic and industrial world in order to provide a broader perspective. The authors take an interdisciplinary approach of physics, chemistry, engineering, materials science and nanotechnology. It appeals to researchers and graduate students.

The increasing prevalence of nanotechnologies has led to the birth of "nanoelectromagnetics," a novel applied science related to the interaction of electromagnetic radiation with quantum mechanical low-dimensional systems. This book provides an overview of the latest advances in nanoelectromagnetics, and presents contributions from an interdisciplinary community of scientists and technologists involved in this research topic. The aspects covered here range from the synthesis of nanostructures and nanocomposites to their characterization, and from the design of devices and systems to their fabrication. The book also focuses on the novel frontier of terahertz technology, which has been expanded by the impressive strides made in nanotechnology, and presents a comprehensive overview of the: - synthesis of various nanostructured materials; - study of their electrical and optical properties; - use of nano-sized elements and nanostructures as building blocks for devices; - design and fabrication of nanotechnology devices operating in the THz, IR and optical range. The book introduces the reader to materials like nanocomposites, graphene nanoplatelets, carbon nanotubes, metal nanotubes, and silicon nanostructures; to devices like photonic crystals, microcavities, antennas, and interconnects; and to applications like sensing and imaging, with a special emphasis on the THz frequency range.

Metal Nanostructures for Photonics presents updates on the development of materials with enhanced optical properties and the demand for novel metal-dielectric nanomaterials that can be used in a variety of technological applications. The book covers the latest progress in the field, including advances in the synthesis, processing, and characterization of metal nanostructures and their optical properties. It also discusses the design and fabrication of metal nanostructures for various applications in photonics. Key topics include: - Synthesis of metal nanostructures - Optical properties of metal nanostructures - Applications of metal nanostructures in photonics The book is intended for researchers and graduate students in materials science, physics, and engineering, as well as for anyone interested in the latest developments in metal nanostructures.
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This book presents synthesis techniques for the preparation of low-dimensional nanomaterials including 0D (quantum dots), 1D (nanowires, nanotubes) and 2D (thin films, few layers), as well as their potential applications in nanoelectronic systems. It focuses on the size effects involved in the transition from bulk materials to nanomaterials; the electronic properties of nanoscale devices; and different classes of nanomaterials from microelectronics to nanoelectronics, to molecular electronics. Furthermore, it demonstrates the structural stability, physical, chemical, magnetic, optical, electrical, thermal, electronic and mechanical properties of the nanomaterials. Subsequent chapters address their characterization, fabrication techniques from lab-scale to mass production, and functionality. In turn, the book considers the environmental impact of nanotechnology and novel applications in the mechanical industries, energy harvesting, clean energy, manufacturing materials, electronics, transistors, health and medical therapy. In closing, it addresses the combination of biological systems with nanoelectronics and highlights examples of nanoelectronic–cell interfaces and other advanced medical applications. The book answers the following questions:

- What is different at the nanoscale?
- What is new about nanoscience?
- What are nanomaterials (NMs)?
- What are the fundamental issues in nanomaterials?
- Where are nanomaterials found?
- What nanomaterials exist in nature?
- What is the importance of NMs in our lives?
- Why so much interest in nanomaterials?
- What is at nanoscale in nanomaterials?
- What is graphene?
- Are pure low-dimensional systems interesting and worth pursuing?
- Are nanotechnology products currently available?
- What are sensors?
- How can Artificial Intelligence (AI) and nanotechnology work together?
- What are the recent advances in nanoelectronic materials?
- What are the latest applications of NMs?

This book describes various aspects of nanoscience and nanotechnology. It begins with an introduction to nanoscience and nanotechnology and includes a historical prospective, nanotechnology working in nature, man-made nanomaterial and impact of nanotechnology illustrated with examples. It goes on to describes general synthetic approaches and strategies and also deals with the characterization of nanomaterial using modern tools and techniques to give basic understanding to those interested in learning this emerging area. It then deals with different kinds of nanomaterial such as inorganics, carbon based-, nanocomposites and self-assembled/supramolecular nano structures in terms of their varieties, synthesis, properties etc. In addition, it contains chapters devoted to unique properties with mathematical treatment wherever applicable and the novel applications dealing with information technology, pollution control (environment, water), energy, nanomedicine, healthcare, consumer goods etc.
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Applications of Nanomaterials: Advances and Key Technologies discusses the latest advancements in the synthesis of various types of nanomaterials. The book's main objective is to provide a comprehensive review regarding the latest advances in synthesis protocols that includes up-to-date data records on the synthesis of all kinds of inorganic nanostructures using various physical and chemical methods. The synthesis of all important nanomaterials, such as carbon nanostructures, Core-shell Quantum dots, Metal and metal oxide nanostructures, Nanoferrites, polymer nanostructures, nanofibers, and smart nanomaterials are discussed, making this a one-stop reference resource on research accomplishments in this area. Leading researchers from industry, academia, government and private research institutions across the globe have contributed to the book. Academics, researchers, scientists, engineers and students working in the field of polymer nanocomposites will benefit from its solutions for material problems. Provides an up-to-date data record on the synthesis of all kinds of organic and inorganic nanostructures using various physical and chemical methods Presents the latest advances in synthesis protocols Includes the latest techniques used in the physical and chemical characterization of nanomaterials Covers the characterization of all the important materials groups, such as carbon nanostructures, core-shell quantum dots, metal and metal oxide nanostructures, nanoferrites, polymer nanostructures and nanofibers

This book discusses electrons and photons in and through nanostructures by the first-principles quantum mechanical theories and fundamental concepts (a unified coverage of nanostructured electronic and optical components) behind nanoelectronics and optoelectronics, the material basis, physical phenomena, device physics, as well as designs and applications. The combination of viewpoints presented in the book can help foster further research and cross-disciplinary interaction needed to surmount the barriers facing future generations of technology design.

When solids are reduced to the nanometer scale, they exhibit new and exciting behaviors which constitute the basis for a new generation of electronic devices. Nanotechnology for Microelectronics and Optoelectronics outlines in detail the fundamental solid-state physics concepts that explain the new properties of matter caused by this reduction of solids to the nanometer scale. Applications of these electronic properties is also explored, helping students and researchers to appreciate the current status and future potential of nanotechnology as applied to the electronics industry. Explains the behavioral changes which occur in solids at the nanoscale, making them the basis of a new generation of electronic devices Laid out in text-reference style: a cohesive and specialised introduction to the fundamentals of nanoelectronics and nanophotonics for students and researchers alike

During the past decade, research and development in the area of synthesis and applications of different nanostructured titanium dioxide have become tremendous. This book briefly describes properties, production, modification and applications of nanostructured titanium dioxide focusing in particular on photocatalytic activity. The physicochemical properties of nanostructured titanium dioxide are highlighted and the links between properties and applications are emphasized. The preparation of TiO2 nanomaterials, including nanoparticles, nanorods, nanowires, nanosheets, nanofibers, and nanotubes are primarily categorized by their preparation method (sol-gel and hydrothermal processes). Examples of early applications of nanostructured titanium dioxide in dye-sensitized solar cells, hydrogen production and storage, sensors, rechargeable batteries, electrocatalysis, self-cleaning and antibacterial surfaces and photocatalytic cancer treatment are reviewed. The review of modifications of TiO2 nanomaterials is mainly focused on the research related to the modifications of the optical properties of TiO2 nanomaterials, since many applications of TiO2 nanomaterials are closely related to their optical properties. Photocatalytic removal of various pollutants using pure TiO2 nanomaterials, TiO2-based nanoclays and non-metal doped nanostructured TiO2 are also discussed.

This book introduces the latest advances made in both fundamental studies and potential applications of upconversion nanomaterials, particularly in the field of high-resolution in vitro bioanalysis and in vivo imaging. This book starts with the synthesis and characterization, and focuses on applications ranging from materials science to biology. Above all, it describes cutting-edge advances in upconversion nanophosphor (UCNP)-based applications in multiplexed encoding, guest delivery and release systems, photodynamic therapy (PDT), solar cells, photocatalysis and so on. The major barriers that currently prevent UCNPs from being used in mainstream biological imaging and therapy are also described, along with several strategies that are currently being explored to overcome these challenges.
Recent advances in computational physics and chemistry have led to greater understanding and predictability of the electronic and optical properties of materials. This understanding can be used to impact directly the development of future devices (whose properties depend on the underlying materials) such as light-emitting diodes (LEDs) and photovoltaics. In particular, density functional theory (DFT) has become the standard method for predicting the ground-state properties of solid-state systems, such as total energies, atomic configurations and phonon frequencies. In the same period, the so-called many-body perturbation theory techniques based on the dynamics of the single-particle and two-particle Green’s function have become one of the standard methods for predicting the excited state properties associated with the addition of an electron, hole or electron-hole pair into a material. The GW and Bethe-Salpeter equation (GW-BSE) technique is a particularly robust methodology for computing the quasiparticle and excitonic properties of materials. The challenge over the last several years has been to apply these methods to increasingly complex systems. Nano-materials are materials that are very small (on the order of a nanometer) in at least one dimension (e.g., molecules, tubes/rods and sheets). These materials are of great interest to researchers because they exhibit new and interesting physical and electronic properties compared to those of conventional bulk crystals. These physical properties can often be tuned by controlling the geometry of the materials (for example, the chiral angle of a nanotube). Various DFT computer packages have been optimized to compute the ground-state properties of large systems and nano-materials. However, the application of the GW-BSE methodology to large systems and large nano-materials is often thought to be too computationally demanding. In this work, we will discuss research towards understanding the electronic and optical properties of nano-materials using (and extending) first-principles computational techniques, namely the GW-BSE technique for applications to large systems and nano-materials in particular. While the GW-BSE approach has, in the past, been prohibitively expensive on systems with more than 50 atoms, in Chapter 2, we show that through a combination methodological and algorithmic improvements, the standard GW-BSE approach can be applied to systems of 500-1000 atoms or 100 AU x 100 AU x 100 AU unit cells. We show that nearly linear parallel scaling of the GW-BSE methodology can be obtained up to tens of thousands (and beyond) of CPUs on current and future high performance supercomputers. In Chapter 3, we will discuss improving the DFT starting point of the GW-BSE approach through the use of COHSEX exchange-correlations functionals to create a nearly diagonal self-energy matrix. We show applications of this new methodology to molecular systems. In Chapter 4, we discuss the application of the GW-BSE methodology to semiconducting single-walled carbon nanotubes (SWCNTs) and the discovery of novel many-body physics in 1D semiconductors. In Chapter 5, we discuss the application of the GW-BSE methodology to metallic SWCNTs and graphene and the discovery of unexpectedly strong excitonic effects in low-dimensional metals and semi-metals.
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This book focuses on functional aspects of nanostructured materials that have a high relevance to immediate applications, such as catalysis, energy harvesting, energy storage, optical properties and surface functionalization via self-assembly. Additionally, there are chapters devoted to massive nanostructured materials and composites and covering basic properties and requirements of this new class of engineering materials. Especially the issues concerning stability, reliability and mechanical performance are mandatory aspects that need to be regarded carefully for any nanostructured engineering material.

The conference was a forum to discuss recent developments in the growth and characterization of nano-structured materials, the synthesis of novel materials and their incorporation into devices with optical and electronic properties determined by nanoscale features, and the theoretical modeling of electronic, optical, magnetic and thermal properties of such systems.

The common belief is that light is completely reflected by metals. In reality they also exhibit an amazing property that is not so widely known: under some conditions light flows along a metallic surface as if it were glued to it. Physical phenomena related to these light waves, which are called Surface Plasmon Polaritons (SPP), have given rise to the research field of plasmonics. This thesis explores four interesting topics within plasmonics: extraordinary optical transmission, negative refractive index metamaterials, plasmonic devices for controlling SPPs, and field enhancement phenomena near metal nanoparticles.

During the past decade, research and development in the area of synthesis and applications of different nanostructured titanium dioxide have become tremendous. This book briefly describes properties, production, modification and applications of nanostructured titanium dioxide focusing in particular on photocatalytic activity. The physicochemical properties of nanostructured titanium dioxide are highlighted and the links between properties and applications are emphasized. The preparation of TiO₂ nanomaterials, including nanoparticles, nanorods, nanowires, nanosheets, nanofibers, and nanotubes are primarily categorized by their preparation method (sol-gel and hydrothermal processes). Examples of early applications of nanostructured titanium dioxide in dye-sensitized solar cells, hydrogen production and storage, sensors, rechargeable batteries, electrocatalysis, self-cleaning and antibacterial surfaces and photocatalytic cancer treatment are reviewed. The review of modifications of TiO₂ nanomaterials is mainly focused on the research related to the modifications of the optical properties of TiO₂ nanomaterials, since many applications of TiO₂ nanomaterials are closely related to their optical properties. Photocatalytic removal of various pollutants using pure TiO₂ nanomaterials, TiO₂-based nanoclays and non-metal doped nanostructured TiO₂ are also discussed.

Filling the gap for a description of the optical properties of small particles with sizes less than 1000 nm and to provide a comprehensive overview on the spectral behavior of nanoparticulate matter, this is the most up-to-date reference on the optical physics of nanoparticle systems. The author, an expert in the field with both academic and industrial experience, concentrates on the linear optical properties, elastic light scattering and absorption of single nanoparticles and on reflectance and transmittance of nanoparticle matter.

Nanostructured materials is one of the hottest and fastest growing areas in today's materials science field, along with the related field of solid state physics. Nanostructured materials and their based technologies have opened up exciting new possibilities for future applications in a number of areas including aerospace, automotive, x-ray technology, batteries, sensors, color imaging, printing, computer chips, medical implants, pharmacy, and cosmetics. The ability to change properties on the atomic level promises a revolution in many realms of science and technology. Thus, this book details the high level of activity and significant findings are available for those involved in research and development in the field. It also covers industrial findings and corporate support. This five-volume set summarizes fundamentals of nano-science in a comprehensive way. The contributors enlisted by the editor are at elite institutions worldwide. Key Features * Provides comprehensive coverage of the dominant
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This book focuses on the fundamental phenomena at nanoscale. It covers synthesis, properties, characterization and computer modelling of nanomaterials, nanotechnologies, bionanotechnology, involving nanodevices. Further topics are imaging, measuring, modeling and manipulating of low dimensional matter at nanoscale. The topics covered in the book are of vital importance in a wide range of modern and emerging technologies employed or to be employed in most industries, communication, healthcare, energy, conservation, biology, medical science, food, environment, and education, and consequently have great impact on our society.

Nano-Optics: Fundamentals, Experimental Methods, and Applications offers insights into the fundamentals and industrial applications of nanoscale light-emitting materials and their composites. This book serves as a reference, offering an overview of existing research, with a particular focus on industrial applications. Nano-optics is the branch of nanoscience and nanotechnology that deals with interaction of light with nanoscale objects. This book explores the materials, structure, manufacturing techniques, and industrial applications of nano-optics. The applications discussed include healthcare, communication, astronomy, and satellites. Explains the major manufacturing techniques for light-emitting nanoscale materials Discusses how nanoscale optical materials are being used in a range of industrial applications Assesses the challenges of using nano-optics in a mass-production context

Materials can be tailored on the nano-scale to show properties that cannot be found in bulk materials. Often these properties reveal themselves when electromagnetic radiation, e.g. light, interacts with the material. Numerous examples of such types of materials are found in nature. There are for example many insects and birds with exoskeletons or feathers that reflect light in special ways. Of special interest in this work is the scarab beetle Cetonia aurata which has served as inspiration to develop advanced nanostructures due to its ability to turn unpolarized light into almost completely circularly polarized light. The objectives of this thesis are to design and characterize bioinspired nanostructures and to develop optical methodology for their analysis. Mueller-matrix ellipsometry has been used to extract optical and structural properties of nanostructured materials. Mueller-matrix ellipsometry is an excellent tool for studying the interaction between nanostructures and light. It is a non-destructive method and provides a complete description of the polarizing properties of a sample and allows for determination of structural parameters. Three types of nanostructures have been studied. The first is an array of carbon nanobers grown on a conducting substrate. Detailed information on physical symmetries and band structure of the material were determined. Furthermore, changes in its optical properties when the individual nanobers were electromechanically bent to alter the periodicity of the photonic crystal were studied. The second type of nanostructure studied is bioinspired films with nanospirals of InxAl1–xN which reflect light with a high degree of circular polarization in a narrow spectral band. These nanostructures were grown under controlled conditions to form columnar structures with an internally graded refractive index responsible for the ability to reflect circularly polarized light. Finally, angle-dependent Mueller matrices were recorded of natural nanostructures in C. aurata with the objective to refine the methodology for structural analysis. A Cloude sum decomposition was applied and a more stable regression-based decomposition was developed for deepened analysis of these depolarizing Mueller matrices. It was found that reflection at near-normal incidence from C. aurata can be described as a sum reflection of a mirror and a left-handed circular polarizer. At oblique incidence the description becomes more complex and involves additional optical components.

Ellipsometry is a powerful tool used for the characterization of thin films and multi-layer semiconductor structures. This book deals with fundamental principles and applications of spectroscopic ellipsometry (SE). Beginning with an overview of SE technologies the text moves on to focus on the data analysis of results obtained from SE, Fundamental data analyses, principles and physical backgrounds and the various materials used in different fields from LSI industry to biotechnology are described. The
Photonic crystal nanostructures, whose photonic properties can be tuned in response to external stimuli, are desired for a wide range of applications in colour displays, biological and chemical sensors, and inks and paints. Until now there is no single resource which gives a complete overview of these exciting smart materials. Responsive Photonic Nanostructures: Smart Nanoscale Optical Materials details the fabrication of photonic crystal structures through self-assembly approaches, general strategies and approaches for creating responsive photonic structures for different responsive systems such as chemical, optical, electrical and magnetic as well as their applications. With contributions from leading experts in the field, this comprehensive summary on Responsive Photonic Nanostructures is suitable for postgraduates and researchers in academia and industry interested in smart materials and their potential applications.

Nanotechnology Provides comprehensive coverage of the dominant technology of the 21st century Written by a truly international list of contributors.

Three types of nanostructured materials have been investigated: C60 on InP (100), Indium clusters on InP (100) and luminescent alkylated-Si quantum dots. The growth model and electronic structure of C60 molecules adsorbed on InP (100) were studied by XPS and UPS as a function of coverage and annealing temperature. The evolution of clean, In-terminated InP (100)-(2 x 4) surfaces is investigated by SRPES as a function of annealing temperature. During the course of illumination with 145 eV photons we have monitored the evolution of the Si 2p core level, and observed in real time a splitting and growth of a new Si 2p component assigned to the Si4+ ionic state of Si. This new peak is attributed to in situ oxidation of Si quantum dots caused by photo-induced reaction with water, multilayers of which are present on the surface of the as-introduced quantum dots. XEOL reveals that two bands are active upon soft X-ray photon excitation. Surprisingly the 390 nm band (blue light) is the most intense, which is quite different to the result for UV photoexcitation, where the 650 nm band is the most prominent one (orange light).

While the chemistry, physics, and optical properties of simple atoms and molecules are quite well understood, this book demonstrates that there is much to be learned about the optics of nanomaterials. Through comparative analysis of the size-dependent optical response from nanomaterials, it is shown that although strides have been made in computational chemistry and physics, bridging length scales from nano to macro remains a major challenge. Organic, molecular, polymer, and biological systems are shown to be potentially useful models for assembly. Our progress in understanding the optical properties of biological nanomaterials is important driving force for a variety of applications.

Silicon-Based Hybrid Nanoparticles: Fundamentals, Properties, and Applications focuses on the fundamental principles and promising applications of silicon-based hybrid nanoparticles in nanoelectronics, energy storage/conversion, catalysis, sensors, biomedicine, environment and imaging. This book is an important reference source for materials scientists and engineers who are seeking to understand more about the major properties and applications of silicon-based hybrid nanoparticles. As the hybridization of silicon nanoparticles with other semiconductors or metal oxides nanoparticles may exhibit superior features, when compared to lone, individual nanoparticles, this book provides the latest insights. In addition, the silicon/iron oxide hybrid nanoparticles also possess excellent fluorescence, super-paramagnetism, and biocompatibility that can be effectively used for the diagnostic imaging system in vivo. Similarly, gold-silicon nanohybrids could be used as highly efficient near-infrared hyperthermia agents for cancer cell destruction. Outlines the major thermal, electrical, optical, magnetic and toxic properties of silicon-based hybrid nanoparticles Describes major applications in energy, environmental science and catalysis Assesses the major challenges to manufacturing silicon-based nanostructured materials on an industrial scale.