Cement Based Materials

The 3rd International Symposium on Nanotechnology in Construction (NICOM 3) follows the highly successful NICOM 1 (Paisley, UK 2003) and NICOM 2 (Bilbao, Spain 2005) Symposia. The NICOM3 symposium was held in Prague, Czech Republic from May 31 to June 2, 2009 under the auspices of the Czech Technical University in Prague. It was a cross-disciplinary event, bringing together R&D experts and users from different fields all with interest in nanotechnology and construction. The conference was aimed at: Understanding of internal structures of existing construction materials at nano-scale Modification at nano-scale of existing construction materials. Production and properties of nanoparticulate materials, nanotubes and novel polymers. Modeling and simulation of nanostructures. Instrumentation, techniques and metrology at nano-scale. Health and safety issues and environmental impacts related to nanotechnology during research, manufacture and product use. Review of current legislation. Societal and commercial impacts of nanotechnology in construction, their predictions and analysis.

Nanotechnology in Construction

Nanotechnology has already demonstrated surprising potential for improving the performance of construction materials and many of these recent developments were facilitated by NICOM symposia. The NICOM5 proceedings will cover the emerging opportunities and future use of nanotechnology in construction and will illustrate the broad potential for application of nanotechnology to challenging problems involving materials and infrastructure.

Nanomaterials-Based Coatings

New Materials in Civil Engineering provides engineers and scientists with the tools and methods needed to meet the challenge of designing and constructing more resilient and sustainable infrastructures. This book is a valuable guide to the properties, selection criteria, products, applications, lifecycle and recyclability of advanced materials. It presents an A-to-Z approach to all types of materials, highlighting their key performance properties, principal characteristics and applications. Traditional materials covered include concrete, soil, steel, timber, fly ash, geosynthetic, fiber-reinforced concrete, smart materials, carbon fiber and reinforced polymers. In addition, the book covers nanotechnology and biotechnology in the development of new materials. Covers a variety of materials, including fly ash, geosynthetic, fiber-reinforced concrete, smart materials, carbon fiber reinforced polymer and waste materials. Provides a “one-stop source of information for the latest materials and practical applications

Includes a variety of different use case studies
Structure and Performance of Cements, Second Edition

Book Advances in Nanofibers is a research publication that covers original research on developments within the Nanofibers field of study. The book is a collection of reviewed scholarly contributions written by different authors. Each scholarly contribution represents a chapter and each chapter is complete in itself but related to the major topics and objectives. The target audience comprises scholars and specialists in the field.

Progress in Nanotechnology

H F W Taylor was for many years Professor of Inorganic Chemistry at the University of Aberdeen, Scotland. Since 1948, his main research interest has been the chemistry of cement. His early work laid the foundations of our understanding of the structure at the nanometre level of C-S-H, the principal product formed when cement is mixed with water, and the one mainly responsible for its hardening. Subsequent studies took him into many additional aspects of the chemistry and materials science of cement and concrete. His work has been recognized by Fellowships and by other honours and awards from many scientific societies in the UK, USA and elsewhere. This second edition of Cement Chemistry addresses the chemistry and materials science of the principal silicate and aluminate cements used in building and Civil Engineering. Emphasis throughout is on the underlying science. The book deals more specifically with the chemistry of Portland cement manufacture and the nature of the resulting product, the processes that occur when this product is mixed with water, the nature of the hardened material, the chemistry of other types of hydraulic cement, and chemical and microstructural aspects of concrete, including processes that affect its durability. Since the first edition of this book was published in 1990, research throughout the world has greatly augmented our knowledge in all these areas. The present edition has been updated and revised to take account of these advances. The reader will acquire a solid understanding of the subject and will be better equipped to deal with the problems and pitfalls that can arise in engineering practice as a result of inadequate understanding of the relevant chemistry. It will serve both as an introduction to those entering the subject for the first time and as a guide to the latest developments for those already experienced in the field.

Advanced Research on Nanotechnology for Civil Engineering Applications

This book focuses on the application of carbon nanotubes and carbon nanofibers in traditional concretes based on Portland cement. Fundamental information is given related to the production technologies of carbon nanotubes and carbon nanofibers, as well as concretes and methods of incorporation. It also contains a section focusing on the possible negative effects of carbon nanotubes and carbon nanofibers on animals and humans. The book indicates benefits and possible problems related to the application of carbon nanotubes and carbon nanofibers in concrete. It is designed to be easy to access and digest for the reader, aiming to reach an audience not only from academia, but also from the construction industry, materials producers, and contractors who might work with nanomaterials. Outlines the major properties and synthesis methods for carbon nanomaterials in concrete engineering; Explains the role of carbon nanotubes and nanofibers in creating high-performance concrete; Assesses the major challenges of integrating carbon nanomaterials into concrete manufacture on an industrial scale.

Durability and Life Prediction in Biocomposites, Fibre-Reinforced Composites and Hybrid Composites

Biopolymeric Nanomaterials: Fundamentals and Applications outlines the fundamental design concepts and emerging applications of biopolymeric nanomaterials. The book also provides information on emerging applications of biopolymeric nanomaterials, including in biomedicine, manufacturing and water purification, as well as assessing their physical, chemical and biological properties. This is an important reference source for materials scientists, engineers and biomedical scientists who are seeking to increase their understanding of how polymeric nanomaterials are being used for a range of biomedical and industrial applications. Biopolymeric nanomaterials refer to biocompatible nanomaterials, consisting of biopolymers, such as protein (silk, collagen, gelatin, β-casein, zein, and albumin), protein-mimicked polypeptides and polysaccharides (chitosan, alginate, pullulan, starch, and heparin). Biopolymeric nanomaterials may be used as (i) delivery systems for bioactive compounds in food application, (ii) for delivery of therapeutic molecules (drugs and genes), or for (iii) tissue engineering. Provides information on the design concepts and synthesis of biopolymeric nanomaterials in biomedical and industrial applications. Highlights the major properties and processing methods for biopolymeric nanomaterials Assesses the major challenges of producing biopolymeric nanomaterials on an industrial scale.
Nanotechnology in Eco-efficient Construction

Unique in its focus on functional properties, this book examines the resistive, piezoresistive, thermoelectric, and electromagnetic behavior of multifunctional cement-based materials for reduced cost, improved durability and maintenance, and optimization of various structural designs. The author analyzes cement-based compounds for enhancing a wide-range of structures, including buildings, bridges, highways, automobiles, and aircrafts, exploring characteristics such as vibration damping, strain sensing, electromagnetic and magnetic shielding, electrical conductivity, and thermal insulation for improved structure stability and performance.

Nano-Engineered Cementitious Composites

Until recently, much of the development of building materials has predominantly focused on producing cheaper, stronger and more durable construction materials. More recently attention has been given to the environmental issues in manufacturing, using, disposing and recycling of construction materials. Sustainability of construction materials brings together a wealth of recent research on the subject. The first part of the book gives a comprehensive and detailed analysis of the sustainability of the following building materials: aggregates; timber, wood and bamboo; vegetable fibres; masonry; cement, concrete and cement replacement materials; metals and alloys; glass; and engineered wood products. A final group of chapters cover the use of waste tyre rubber in civil engineering works, the durability of sustainable construction materials and nanotechnologies for sustainable construction. With its distinguished editor and international team of contributors, Sustainability of construction materials is a standard reference for anyone involved in the construction and civil engineering industries with an interest in the highly important topic of sustainability. Provides a comprehensive and detailed analysis of the sustainability of a variety of construction materials ranging from wood and bamboo to cement and concrete. Assesses the durability of sustainable construction materials including the utilisation of waste tyre rubber and vegetable fibres. Collates a wealth of recent research including relevant case studies as well as an investigation into future trends.

Nanomaterials for Biocatalysis

Transportation Research Record: Journal of the Transportation Research Board, No. 2142 includes 20 papers that report on a laboratory study of a self-healing cementitious composite, nanocement enhancement of reactive powder concrete, nanocellulose and microcellulose fibers, nanotechnology to manipulate mortar performance, and an exploratory investigation of nanomaterials. This issue of the TRR also examines nanoporous thin film technology, calcium silicate hydrate, molecular dynamics of hydrated cement, carbon nanofibers and nanotubes in cementitious composites, nanoengineering ultra-high-performance concrete, and a road map for research for nanotechnology-based concrete materials.

Handbook of Research on Diverse Applications of Nanotechnology in Biomedicine, Chemistry, and Engineering

Magnetic Nanoparticle-Based Hybrid Materials: Fundamentals and Applications introduces the principles, properties, and emerging applications of this important materials system. The hybridization of magnetic nanoparticles with metals, metal oxides and semiconducting nanoparticles may result in superior properties. The book reviews the most relevant hybrid materials, their mechanisms and properties. Then, the book focuses on the rational design, controlled synthesis, advanced characterizations and in-depth understanding of structure-property relationships. The last part addresses the promising applications of hybrid nanomaterials in the real world such as in the environment, energy, medicine fields. Magnetic Nanoparticle-Based Hybrid Materials: Fundamentals and Applications comprehensively reviews both the theoretical and experimental approaches used to rapidly advance nanomaterials that could result in new technologies that impact day-to-day life and society in key areas such as health and the environment. It is suitable for researchers and practitioners who are materials scientists and engineers, chemists or physicists in academia and R&D. Provides in-depth information on the basic principles of magnetic nanoparticles-based hybrid materials such as synthesis, characterization, properties, and magnon interactions. Discusses the most relevant hybrid materials systems including integration of metals, metal oxides, polymers, carbon and more. Addresses the emerging applications in medicine, the environment, energy, sensing, and computing enabled by magnetic nanoparticles-based hybrid materials.

Nanotechnology for Smart Concrete
In this book, architects, interior designers and designers will find an introduction to the functions and use of nano materials, specifically tailored to their needs and illustrated by numerous international project examples.

**New Materials in Civil Engineering**

**Cement Industry**

Nanotechnology for Smart Concrete discusses the advantages and applications of nanomaterials in concrete including high-strength performance, microstructural improvement, self-healing, energy storage, and coatings.

**Advances in Nanofibers**

Durability and Life Prediction in Biocomposites, Fibre-Reinforced Composites and Hybrid Composites focuses on the advanced characterization techniques used for the analysis of composite materials developed from natural fiber/biomass, synthetic fibers and a combination of these materials used as fillers and reinforcements to enhance materials performance and utilization in automotive, aerospace, construction and building components. The book presents key aspects of fracture and failure in natural/synthetic, fiber reinforced, polymer based composite materials, ranging from crack propagation, to crack growth, and from notch-size effect, to damage-tolerant design. Written by leading experts in the field, and covering composite materials developed from different natural fibers and their hybridization with synthetic fibers, the book’s chapters provide cutting-edge, up-to-date research on the characterization, analysis and modelling of composite materials. Contains contributions from leading experts in the field Discusses recent progress on failure analysis, SHM, durability, life prediction and the modelling of damage in natural fiber-based composite materials Covers experimental, analytical and numerical analysis Provides detailed and comprehensive information on mechanical properties, testing methods and modelling techniques

**Nanotechnology in Construction**

Coatings act as multifunctional and smart materials for products, as well as serving as physical barriers or decoration. Nanomaterials-enforced coatings are smarter, stronger and more durable. The barrier performance of organic coatings is enhanced by the incorporation of nanofillers, by decreasing the porosity and zigzagging the diffusion path for deleterious species. Coatings containing nanofillers, therefore have significant barrier properties for corrosion protection and reducing the trend for the coating to blister or delaminate. In addition, the functionalization of nanomaterials has led to advances in smart nanocomposite coatings, such as self-healing, anti-fouling, self-cleaning, antibacterial and cooling coatings. Nanomaterials-based Coatings emphasizes the fundamental concepts and promising applications of nanomaterial-based coatings in anticorrosion, antiwear, antibacterial, antifugal, self-leaning, superhydrophobic, superhard, super heat resistance, solar reflective, photocatalytic and radar absorbing coatings. It is an important information source for those seeking to understand the underlying phenomenal and fundamental mechanisms through which nanoparticles interact with polymeric and metallic matrices to create stronger coatings, and what their major applications are. Highlights the latest methods in design, preparation and characterization techniques for nanomaterials-based coatings Discusses emerging applications of nanomaterials-based coatings, including substrates protection, sustainable energy, environment and healthcare Assesses the major challenges in making nanomaterials-based coatings more reliable and cost-effective

**Construction Biotechnology**

Smart Nanconcretes and Cement-Based Materials: Properties, Modelling and Applications explores the fundamental concepts and applications of smart nanconcretes with self-healing, self-cleaning, photocatalytic, antibacterial, piezoelectrical, heating and conducting properties and how they are used in modern high-rise buildings, hydraulic engineering, highways, tunnels and bridges. This book is an important reference source for materials scientists and civil engineers who are looking to enhance the properties of smart nanomaterials to create stronger, more durable concrete. Explores the mechanisms through which active agents are released from nanocontainers
inside concrete Shows how embedded smart nanosensors, including carbon cement-based smart sensors and micro/nano strain-sensors, are used to increase concrete performance. Discusses the major challenges of integrating smart nanomaterials into concrete composites.

**Nanotechnology in Cement and Concrete**

Covering the latest technologies, Nanotechnology in eco-efficient construction provides an authoritative guide to the role of nanotechnology in the development of eco-efficient construction materials and sustainable construction. The book contains a special focus on applications concerning concrete and cement, as nanotechnology is driving significant development in concrete technologies. The new edition has 14 new chapters, including 3 new parts: Mortars and concrete related applications; Applications for pavements and other structural materials; and Toxicity, safety handling and environmental impacts. Civil engineers requiring an understanding of eco-efficient construction materials, as well as researchers and architects within any field of nanotechnology, eco-efficient materials or the construction industry will find this updated reference to be highly valuable. Addresses issues such as toxicity and LCA aspects. New chapters covering safety handling on occupational exposure of nanoparticles and the assessment of personal exposure to airborne nanomaterials Discusses the effects of adding nano-particles on the durability and on the properties of geopolymers.

**Nanotechnology in Cement-Based Construction**

This book focuses on civil engineering materials and nanotechnology. Highlighting recent advances in the field of nano-engineered cementitious composites, it discusses their key principles, design and fabrication, testing and characterization, performance and mechanisms, as well as applications. Future developments and remaining challenges are also outlined. Nano-engineered cementitious composites are exceptionally strong, durable and offer multifunctional/smart performance that differs considerably from that of normal cementitious composites. Providing valuable insights into these composites’ future development, the book offers an essential source of information, inspiration, theory and practical guidance for developing sustainable cementitious composites. As such, it will benefit researchers, scientists and engineers in the fields of civil engineering materials and nanotechnology alike.


This Special Issue on “Cement-Based Composites: Advancements in Development and Characterization” presents the latest research and advances in the field of cement-based composites. This Special Issue covers a variety of experimental studies related to fiber-reinforced, photocatalytic, lightweight, and sustainable cement-based composites. Moreover, simulation studies are presented in this Special Issue to provide fundamental knowledge of designing and optimizing the properties of cementitious composites. The presented publications in this Special Issue show the most recent technology in the cement-based composite field.

**Cement-Based Composites**

**Advances in Cement-Based Materials**

Collection of selected papers on current advances in high performance construction materials. Contributions deal with the development, characterization, application procedures, performance and structural design of materials with key potential in civil engineering works. Materials treated are fibre reinforced concrete, high performance concrete, sel

**High-Performance Construction Materials**
Magnetic Nanoparticle-Based Hybrid Materials

Carbon Nanotubes and Carbon Nanofibers in Concrete—Advantages and Potential Risks

This book presents the first comprehensive text on construction biomaterials and bioprocesses. It details aspects of construction biotechnology, a new interdisciplinary area involving applications of environmental and industrial microbiology and biotechnology in geotechnical and civil engineering. It also critically reviews all existing and potential construction biotechnology processes. It discusses a number of topics including the biotechnological production of new construction materials such as self-healing concrete, construction biocomposites, construction bioplastics, and biotechnological admixtures to cement. It also addresses construction-related processes like biocementation, bioleaching, soil surface fixation and biosealing, microbial cements and grouts, the biocoating of construction material surfaces, the microbiology and biosafety of the construction environment, the prevention of biocorrosion as well as biodeterioration and biofouling in civil engineering. Biomediated precipitation of calcium, magnesium, and iron compounds as carbonates, phosphates, sulphides, and silicate minerals in soil for its clogging and strengthening are considered from geotechnical, chemical, and microbiological points of view. It offers an overview of the basic microbiology that will enable civil engineers to perform the construction biogeochemical processes. Design principles and considerations for different field implementations are discussed from a practical point of view. The book can be used as a textbook for graduate and senior undergraduate students in biotechnology, civil engineering and environmental engineering as well as a reference book for researchers and practitioners working in this new interdisciplinary area.

Nanotechnology of Concrete

Many books on new smart materials are available, but specialized analysis of particular topics is still in high demand. This multiauthor book focuses on applying nanotechnology to cement-based materials to make numerous engineering applications possible. The addition of novel smart nanofillers allows the development of multifunctional composite materials, not just limited to improving mechanical strength, but also including several enhanced features. Special attention is devoted to types of nano-inclusions, novel techniques to mix components, and analysis of properties that can be achieved by paste, mortar, or concrete if added with nanofillers. Among these properties, the capability of self-sensing is very promising. Moreover, the use of phase-changing materials improves the energy efficiency of nanocomposites, resulting in important applications in engineering. Particular attention is also focused on energy harvesting and electromagnetic shielding properties. Comprehensive and up to date, this is an important reference book that not only provides in-depth information about recent developments and perspectives in this field but also discusses topics that promise major developments in the near future.

Nanomaterials in Concrete

Cement is the basis of the building and construction industry and of fundamental importance for many civil engineering applications. As such, the cement industry is one of the key industries worldwide necessary for the current and future sustainable development of society. Despite its undisputed importance, the cement industry is one of those industrial branches predominately responsible for high energy consumption and excessive generation of large amounts of carbon dioxide and other contaminants that significantly endanger human health and the environment and contributes to global warming. In this context, nanomaterials, polymeric materials, and natural additives are
being used for cement enhancement in various applications. This book examines these novel materials and their optimization, characterization, and sustainable application in the building industry and for stabilizing hazardous waste.

**Nanotechnology in Concrete Materials**

Cement-based materials have been used by humans nearly since the dawn of civilization. The Egyptians used lime and gypsum cement to bind their aggregate materials, mud and straw, resulting in bricks that are used for building their famous Egyptian pyramids (between 3000 and 2500 BC). Hydrated cement is a cement material bonded together with water and used for building construction; it is characterized by acceptable chemical, physical, thermal, mechanical, and structural stability. It plays a main role in the creation of vessels for storage, roads to travel on, weather-resistant structure for protection, inert hard stabilizer for hazardous wastes, and so on. Due to the composition of these materials and their advantages, it has been practiced in different applications. Cement is an essential component of making concrete, the single most prevalent building material used worldwide for construction, skyscrapers, highways, tunnels, bridges, hydraulic dams, and railway ties. Besides their numerous desired properties, there are some undesirable features. To overcome these disadvantages, several studies were established to prepare, improve, and evaluate innovative cement-based materials. Due to the composition of these materials and their advantages, it has been practiced in different applications. Cement is an essential component of making concrete, the single most prevalent building material used worldwide for construction, skyscrapers, highways, tunnels, bridges, hydraulic dams, and railway ties. Besides their numerous desired properties, there are some undesirable features. To overcome these disadvantages, several studies were established to prepare, improve, and evaluate innovative cement-based materials. Due to the composition of these materials and their advantages, it has been practiced in different applications. Cement is an essential component of making concrete, the single most prevalent building material used worldwide for construction, skyscrapers, highways, tunnels, bridges, hydraulic dams, and railway ties. Besides their numerous desired properties, there are some undesirable features. To overcome these disadvantages, several studies were established to prepare, improve, and evaluate innovative cement-based materials. Despite its oldness and deep research, every year several methods and materials evolve and so do cement technology. This book intends to provide a comprehensive overview on recent advances in the evaluation of these materials.

**Biodegradation and Biodeterioration at the Nanoscale**

A recent initiative within the civil engineering field is the use of nanotechnology and materials within the construction industry. While there has been great success in the adoption of various nanomaterials, there is still room for development and improvement. Advanced Research on Nanotechnology for Civil Engineering Applications highlights emergent research and theoretical concepts in the implementation of nanotechnology within the construction, geotechnical, and transportation engineering fields. Examining the application of nanomaterials, current trends within the topic area, and the potential health impacts of material usage on the environment, this book is a pivotal reference for professionals, engineers, students, and researchers.

**Biopolymeric Nanomaterials**

Nanomaterials for Biocatalysis explains the fundamental design concepts and emerging applications of nanoscale biocatalysts, such as bioconversions, bioelectronics, biosensors, biocomputing and therapeutic applications. Nano-biocatalysts refers to the incorporation of enzymes into nanomaterials. These enzyme-enhanced nanocarriers have many advantages, including low mass transfer limitation, high enzyme capacity, better stabilization, and the formation of single-enzyme nanoparticles. Smart nanocontainers have been developed for the smart release of their embedded active substances. These smart releases can be obtained by using smart coatings as their outer nanoshells. In addition, these nanocontainers could protect the enzymes from chemical or metabolic alterations on their delivering pathways towards the target. This is an important reference source for materials scientists and chemical engineers who want to know more about how nanomaterials are being used for biocatalysis applications. Explains the major fabrication techniques and applications of nanobiocatalysts Shows how nanobiocatalysts are used in a variety of environmental and biomedical sectors Assesses the major challenges associated with the widespread manufacture of nanobiocatalysts

**Nanotechnology in Cement-Based Construction**

A fundamental part of modern technology is composed of devices that use special materials as main components. Since the last few decades of the last century and even more recently, a remarkable development has been achieved in new micro- and nanostructured materials with compositional structures and production methods that open unprecedented technological, economic, and ecological perspectives due to high yields, economies of scale, the possibility of reducing weight and size, and the low environmental impact of the equipment that contains them. This book offers a collection of excellent studies that use state-of-the-art methodologies developed by professional researchers from different countries in diverse areas of materials. In this way, this book is particularly useful to academics, scientists, practicing researchers, and postgraduate students whose work relates to the latest nanomaterial technologies.
Nano Materials

This edition of Progress in Ceramic Technology series contains a select compilation of articles on the topic of nanomaterials processing of powders; thin films, wires and tubes; and composites that were previously published in The American Ceramic Society Bulletin, Journal of the American Ceramic Society, International Journal of Applied Ceramic Technology, Ceramic Engineering and Science Proceedings (CESP) and Ceramic Transactions (CT).

Smart Nanoconcretes and Cement-Based Materials

The importance of nanotechnology related research and development has become recognised worldwide. Substantial public and private investment is now being ploughed into research and development in a number of industrial sectors, where nanotechnology has become established and has led to new commercial products. The construction industry, having major economic significance with nano-scale research and development which is only emerging, offers a wide scope for exploitation of nanotechnology. With international contributions from experts in the field, Nanotechnology in Construction amalgamates previously fragmented research and emerging trends. It reflects the inherent multi-disciplinary nature of nano-scale research in construction and contributions cover a wide spectrum, from highly scientific investigations to futuristic applications. The book is organised into four broad sections, the first reviews and analyses the prospects of exploitation of nanotechnology in construction, the second discusses novel tools and their capabilities, the final two sections show existing significant products where nanotechnology has been already been exploited or where product development is under-way. Nanotechnology in Construction will appeal to researchers already working in this field as well as those wishing to enter it. It will also inform governmental and other funding agencies of the most promising future directions and their related timescales. Practical applications are considered and explanations of the underlying basics are given, raising awareness and understanding of what nanotechnology can offer to construction professionals in general.

Multifunctional Cement-Based Materials

The book presents original work on how nanomaterials are applied to concrete through electromutagenic processes, which modify the microstructure of concrete materials in situ without changing their dimensions or appearance. In essence, it shows how high-performance concrete can be mixed without expensive additives. The book offers a method for dispersing nanoparticles in concrete and explains how their presence reduces porosity, increases strength and prevents cracking—information that can be used for more efficient repair and rehabilitation. Nanomaterials are shown to improve barrier-formation, anti-corrosiveness, and other functions of concrete. Extensive practical guidelines are given on formulation, set-up, mixing, and testing.

Cement Chemistry

Sustainability of Construction Materials

Drawing together a multinational team of authors, this second edition of Structure and Performance of Cements highlights the latest global advances in the field of cement technology. Three broad categories are covered: basic materials and methods, cement extenders, and techniques of examination. Within these categories consideration has been given to environmental issues such as the use of waste materials in cement-burning as supplementary fuels and new and improved methods of instrumentation for examining structural aspects and performance of cements. This book also covers cement production, mineralogy and hydration, as well as the mechanical properties of cement, and the corrosion and durability of cementitious systems. Special cements are included, along with calcium aluminate and blended cements together with a consideration of the role of gypsum in cements. Structure and Performance of Cements is an invaluable key reference for academics, researchers and practitioners alike.

Nanotechnology in Construction

Biodegradation and Biodeterioration at the Nanoscale describes the biodegradation and biodeterioration of materials in the presence of nanomaterials. The book's chapters
focus on the basic principles, action mechanisms and promising applications of advanced nanomaterials, along with their integration with biotechnological processes for controlled degradation and deterioration of materials. In addition, the current research indications, positive or negative environmental impacts, legislation and future directions are also discussed. This book is an important reference source for researchers, engineers and scientists working in environmental remediation, biotechnology, materials science, corrosion and nanotechnology. Provides detailed coverage on how nano-biomaterials degrade and deteriorate Compares how different types of bionanomaterials decompose Explains how the priorities of bionanomaterials affect their deterioration rate

**Nanotechnology in Civil Infrastructure**

Nanotechnology in Civil Infrastructure is a state-of-the art reference source describing the latest developments in nano-engineering and nano-modification of construction materials to improve the bulk properties, development of sustainable, intelligent, and smart concrete materials through the integration of nanotechnology based self-sensing and self-powered materials and cyber infrastructure technologies, review of nanotechnology applications in pavement engineering, development of novel, cost-effective, high-performance and long-lasting concrete products and processes through nanotechnology-based innovative processing of cement and cement paste, and advanced nanoscience modeling, visualization, and measurement systems for characterizing and testing civil infrastructure materials at the nano-scale. Researchers, practitioners, undergraduate and graduate students engaged in nanotechnology related research will find this book very useful.

**New Uses of Micro and Nanomaterials**

Many books on new smart materials are available, but specialized analysis of particular topics is still in high demand. This multi-author book focuses on applying nanotechnology to cement-based materials to make numerous engineering applications possible. The addition of novel smart nanofillers allows the development of multifunctional composite materials, not just limited to improving mechanical strength, but also including several enhanced features. Special attention is devoted to types of nano-inclusions, novel techniques to mix components, and analysis of properties that can be achieved by paste, mortar, or concrete if added with nanofillers. Among these properties, the capability of self-sensing is very promising. Moreover, the use of phase-changing materials improves the energy efficiency of nanocomposites, resulting in important applications in engineering. Particular attention is also focused on energy harvesting and electromagnetic shielding properties. Comprehensive and up to date, this is an important reference book that not only provides in-depth information about recent developments and perspectives in this field but also discusses topics that promise major developments in the near future.

**Nanotechnology for Hematology, Blood Transfusion, and Artificial Blood**

As a paradigm for the future, micro-scale technology seeks to fuse revolutionary concepts in science and engineering and then translate it into reality. Nanotechnology is an interdisciplinary field that aims to connect what is seen with the naked eye and what is unseen on the molecular level. The Handbook of Research on Diverse Applications of Nanotechnology in Biomedicine, Chemistry, and Engineering examines the strengths and future potential of micro-scale technologies in a variety of industries. Highlighting the benefits, shortcomings, and emerging perspectives in the application of nano-scale technologies, this book is a comprehensive reference source for synthetic chemists, engineers, graduate students, and researchers with an interest in the multidisciplinary applications, as well as the ongoing research in the field.