

# **Handbook Of Bioplastics And Biocomposites Engineering Applications**

## **Novel Biocomposite Engineering and Bio-Applications**

Biocomposites: Design and Mechanical Performance describes recent research on cost-effective ways to improve the mechanical toughness and durability of biocomposites, while also reducing their weight. Beginning with an introduction to commercially competitive natural fiber-based composites, chapters then move on to explore the mechanical properties of a wide range of biocomposite materials, including polylactic, polyethylene, polycarbonate, oil palm, natural fiber epoxy, polyhydroxyalkanoate, polyvinyl acetate, polyurethane, starch, flax, poly (propylene carbonate)-based biocomposites, and biocomposites from biodegradable polymer blends, natural fibers, and green plastics, giving the reader a deep understanding of the potential of these materials. Describes recent research to improve the mechanical properties and performance of a wide range of biocomposite materials Explores the mechanical properties of a wide range of biocomposite materials, including polylactic, polyethylene, polycarbonate, oil palm, natural fiber epoxy, polyhydroxyalkanoate, polyvinyl acetate, and polyurethane Evaluates the potential of biocomposites as substitutes for petroleum-based plastics in industries such as packaging, electronic, automotive, aerospace and construction Includes contributions from leading experts in this field

## **Introduction to Bioplastics Engineering**

This book is a printed edition of the Special Issue \"Novel Biocomposite Engineering and Bio-Applications\" that was published in Bioengineering

## Bionanocomposites

Biodegradable plastics made with plant based materials have been available for many years. The term biodegradable means that a substance is able to be broken down into simpler substances by the activities of living organisms, and therefore is unlikely to persist in the environment. There are many different standards used to measure biodegradability, with each country having its own. The requirements range from 90 per cent to 60 per cent decomposition of the product within 60 to 180 days of being placed in a standard composting environment. They may be composed of either bio plastics, which are plastics whose components are derived from renewable raw materials, or petroleum based plastics which contain additives. Biodegradability of plastics is dependent on the chemical structure of the material and on constitution of the final product, not just on the raw materials used for its production. Polyesters play a predominant role as biodegradable plastics due to their potentially hydrolysable ester bonds. Bio based polymers are divided into three categories based on their origin and production; polymer directly extracted from biomass, polymers produced by classical chemical synthesis using renewable biomass monomer and polymers produced by microorganisms or genetically modified bacteria. In response to public concern about the effects of plastics on the environment and in particular the damaging effects of sea litter on animals and birds, legislation is being enacted or is pending in many countries to ban non degradable packing, finishing nets etc. This book basically deals with biodegradable plastics developments and environmental impacts, hydro biodegradable and photo biodegradable, starch synthetic aliphatic polyester blends, difference between standards for biodegradation, polybutylene succinate (pbs) and polybutylene, recent developments in the biopolymer industry, recent advances in synthesis of biopolymers by traditional methodologies, polymers, environmentally degradable synthetic biodegradable polymers as medical devices, polymers produced from classical chemical synthesis from bio based monomers, potential bio based packaging materials, conventional packaging materials, environmental impact of bio based materials: biodegradability and compostability, etc. Environmentally acceptable degradable polymers have been defined as polymers that

degrade in the environment by several mechanisms and culminate in complete biodegradation so that no residue remains in the environment. The present book gives thorough information to biodegradable plastic and polymers. This is an excellent book for scientists engineers, students and industrial researchers in the field of bio based materials.

## **Natural Fibers, Biopolymers, and Biocomposites**

The Handbook of Composites From Renewable Materials comprises a set of 8 individual volumes that brings an interdisciplinary perspective to accomplish a more detailed understanding of the interplay between the synthesis, structure, characterization, processing, applications and performance of these advanced materials. The handbook covers a multitude of natural polymers/ reinforcement/ fillers and biodegradable materials. Together, the 8 volumes total at least 5000 pages and offers a unique publication. This 7th volume Handbook is solely focused on Nanocomposites: Science and Fundamentals. Some of the important topics include but not limited to: preparation, characterization and applications of nano materials from renewable resources; hydrogels and its nanocomposites from renewable resources; preparation of chitin-based nanocomposite materials through gelation with ionic liquid; starch based bionanocomposites; biorenewable nanofiber and nanocrystal; investigation of wear characteristics of dental composite reinforced with rice husk derived nanosilica filler particles; performance of regenerated cellulose/vermiculite nanocomposites fabricated via ionic liquid; preparation, structure, properties and interactions of the PVA/cellulose composites; green composites with cellulose nano-reinforcements; biomass composites from bamboo-based micro/nano fibers; synthesis and medicinal properties of polycarbonates and resins from renewable sources; nanostructured polymer composites with modified carbon nanotubes; organic-inorganic nanocomposites derived from polysaccharides; natural polymer based nanocomposites; cellulose whisker based green polymer composites; poly (lactic acid) nanocomposites reinforced with different additives; nanocrystalline cellulose; halloysite based bionanocomposites; nanostructured composites based on biodegradable polymers and silver nanoparticles;

starch-based biomaterials and nanocomposites; green nanocomposites based on PLA and natural organic fillers; chitin and chitosan based nanocomposites.

## Recycled Plastic Biocomposites

The engineering and utilization of biocomposites is a research field of major scientific and industrial interest worldwide. The biocomposite area is extensive and spans from structured and solid biocomposites (e.g., reinforced bioabsorbable polymers), films (e.g., antimicrobial barriers), to soft biocomposites (e.g., use of alginates, collagen and nanocellulose as components in bioinks for 3D bioprinting). Key aspects in this respect are the appropriate engineering and production of biomaterials, nanofibres, bioplastics, their functionalization enabling intelligent and active materials, processes for effective manufacturing of biocomposites and the corresponding characterization for understanding their properties. The current Special Issue emphasizes the bio-technological engineering of novel biomaterials and biocomposites, considering also important safety aspects in the production and use of bio- and nanomaterials.

## Handbook of Biopolymers and Biodegradable Plastics

This new Handbook provides engineers and scientists with the information and practical guidance needed to successfully design and manufacture products using biopolymers and biodegradable plastics. Biopolymers and biodegradable plastics are a hot issue across the plastics industry, and for many of the industry sectors that use plastic: from packaging to medical devices and from the construction industry to the automotive sector. This book brings together in one place a number of key biopolymer and biodegradable plastics topics-in chapters previously published as well as updated and new chapters-for a broad audience of engineers and scientists, especially those designing with biopolymers and biodegradable plastics or evaluating the options for switching from traditional plastics to biopolymers. Topics covered include preparation, fabrication, applications and recycling (including biodegradability and compostability). Applications in key areas such as films, coatings,

controlled release, and tissue engineering are discussed.

## **Handbook of Thermoplastics, Second Edition**

This book introduces the concept, design and application of green biocomposites, with a specific focus on the current demand for green biocomposites for automotive and aerospace components. It discusses the mathematical background, innovative approaches to physical modelling, analysis and design techniques. Including numerous illustrations, tables, case studies and exercises, the text summarises current research in the field. It is a valuable reference resource for researchers, students and scientists working in the field of materials science.

## **Polymers for Packaging Applications**

This book presents recent advances in the development of biomaterials for industrial applications, and discusses the potential for substituting environmentally hazardous substances with environmentally friendly and degradable components. Focusing on both the material development and production technologies, it reviews different materials, as well as new production technologies and application areas. It also highlights the importance of incorporating organic materials into different composites to enable consumption of otherwise waste materials. Further it addresses biopolymers for the food industry, e.g. edible films and coatings in food production and biodegradable materials; the automotive industry; bio fuels, such as biodiesel based on organic constituents; and green composites in marine applications. Environmental protection aspects related to the protection of cultural heritage, and new nanoparticles, such as nano zerovalent iron, are also reviewed. Aimed at young researchers, professionals, chemical engineers and marine engineers, the book is the result of the joint efforts of different academic and research institutions participating in the WIMB Tempus project, 543898-TEMPUS-1-2013-1-ES-TEMPUS-JPHES, "Development of Sustainable Interrelations between Education, Research and Innovation at WBC Universities in Nanotechnologies and Advanced Materials where Innovation Means

Business", co-funded by the European Union Tempus Program.

## **Bioplastics and Biocomposites**

Natural/Biofiber composites are emerging as a viable alternative to glass fiber composites, particularly in automotive, packaging, building, and consumer product industries, and becoming one of the fastest growing additives for thermoplastics. Natural Fibers, Biopolymers, and Biocomposites provides a clear understanding of the present state

## **Biocomposites: Design and Mechanical Performance**

Advanced Green Materials: Fabrication, Characterization and Applications of Biopolymers and Biocomposites looks at their extraction, purification, modification, and processing for various industrial, biomedical, pharmaceutical, and construction applications. The book comprehensively summarizes recent technical research accomplishments in natural materials and discusses various aspects of natural materials from a chemistry/engineering point of view. The book is unique with contributions from experts working on hybrid biopolymers and bio- composites, bioactive and biodegradable materials, bio-inert polymers and composites, natural polymer and composites, and metallic natural materials. The book will be a useful reference for scientists, academicians, research scholars, and biotechnologists. Advanced biocomposite materials continue to become increasingly popular and important for a broad range of different science and engineering applications. In the race to exploit the unique mechanical, thermal, and electrical properties of these materials, researchers must also address new challenges to predict, understand, and manage the potentially adverse effects they could have on the environment and human lives. The book describes recent developments and applications of biopolymers and biocomposites for applications in various industrial fields. Chapters include original research and the latest reviews in similar fields. Biopolymers and biocomposites occupy an exceptional position in the exciting new world of novel biomaterials. Considering their sustainability, non-toxic properties, and their ability to have tailored properties and

functions, they should be considered as a smart candidate in the advancement of biomaterials technology. Covers all types of biopolymers and advanced industrial applications, from packaging to biomedical therapeutics Discusses the shift from research to industrial large-scale application of biopolymers and biocomposites Emphasizes new strategic trends, such as bio-based and biodegradable additives for bioplastics, PHAs, new lignin-based biopolymers, and new polymers based on terpenes and biosensor applications

## **Advanced Green Materials**

Value-Added Biocomposites: Technology, Innovation, and Opportunity explores advances in research, processing, manufacturing, and novel applications of biocomposites. It describes the current market situation, commercial competition, and societal and economic impacts and advantages of substituting biocomposites for conventional composites, including natural fibers and bioplastics. FEATURES Discusses manufacturing and processing procedures that focus on improving physical, mechanical, thermal, electrical, chemical, and biological properties and achieving required specifications of downstream industries and customers Analyzes the wide range of available base materials and fillers of biocomposites and bioplastics in terms of the strength and weaknesses of materials and economic potential in the market Displays special and unique properties of biocomposites in different market sectors Showcases the insight of expert scientists and engineers with first-hand experience working with biocomposites across various industries Covers environmental factors, life cycle assessment, and waste recovery Combining technical, economic, and environmental topics, this work provides researchers, advanced students, and industry professionals a holistic overview of the value that biocomposites add across a variety of engineering applications and how to balance research and development with practical results.

## **Handbook of Bioplastics and Biocomposites Engineering Applications**

This Handbook is the first to explore the extensive applications made with bioplastics & biocomposites for the packaging, automotive, biomedical, and construction industries. Bioplastics and biocomposites are becoming increasingly prominent because synthetic plastics and glass fiber composites are neither sustainable nor environmentally friendly. The Handbook of Bioplastics and Biocomposites Engineering Applications brings together scientists from academia and industry to report on current research and applications in the bioplastics and biocomposites arena. This new science is interdisciplinary and integrates pure and applied sciences such as chemistry, engineering and materials science. The Handbook focuses on five main categories of applications: Packaging; Civil Engineering; Biomedical; Automotive; General Engineering. The majority of the chapters review the properties, processing, characterization, synthesis and applications of the bio-based and biodegradable polymers and composites including: Polymers such as polylactic acid (PLA), polyhydroxybutyrate (PHB), guar gum based plastics, cellulose polyesters, starch based bioplastics, vegetable oil derived bioplastics, biopolyethylene, chitosan, etc. Thermoplastic and thermosetting bioplastics and biocomposites with a focus on the automobile industry. The ways how to improve the properties of bioplastics, polymer blends, and biocomposites by combining them with both synthetic and natural fillers and reinforcements such as nanoclays, nanotubes (CNTs), and natural fibers (both wood and plant fibers). Studies that expand the boundaries of bioplastics that will allow for the new materials to be applied to most generic engineering applications. The Handbook will be of central interest to engineers, scientists and researchers who are working in the fields of bioplastics, biocomposites, biomaterials for biomedical engineering, biochemistry, and materials science. The book will also be of great importance to engineers in many industries including automotive, biomedical, construction, and food packaging.

## **Green Biocomposites for Biomedical Engineering**

Introduction to Bioplastics Engineering is a practical, user-friendly reference for plastics engineers working with biopolymers and

biodegradable plastics that addresses topics that are required for the successful development of cohesive bioplastic products. While there has been considerable demand for the use of bioplastics in industry, processing these bioplastics is a big challenge. The book provides plastics engineers and researchers with a fundamental, practical understanding of the differences between bioplastics and biodegradable polymers, along with guidance on the different methods used to process bioplastics. The book also covers additives and modifiers for biopolymers and their effect on properties. Examples include commercial applications of bioplastics, current bioplastics being developed, and future trends in the industry. This enables engineers, researchers, technicians, and students to understand the decisive relationship between different processing techniques, morphology, mechanical properties, and the further applications of bio-based polymers. The book presents a true engineering approach for the industry on the processing of biopolymers and biodegradable plastics – discussing the ease of use of the polymer, mechanical and thermal properties, rate of biodegradation in particular environments, and pros and cons of particular bioplastics. Enables engineers, researchers, technicians, and students to understand the decisive relationship between different processing techniques, morphology, mechanical properties, and the further applications of bio-based polymers. Covers additives and modifiers for biopolymers and their effect on properties. Includes examples that illustrate the commercial applications of bioplastics, current bioplastics being developed, and future trends in the industry

## **Biopolymers**

This book is aimed at beginners and students in materials science and researchers in the fields of bionanocomposites, nanotechnology, and analytical chemistry, especially those with an interest in materials for analytical applications. Advanced polymer-based nanocomposite materials continue to become increasingly popular and important for a wide range of science and engineering applications. In the race to exploit the unique mechanical, thermal, and electrical properties of nano- and biocomposite materials, researchers must also address new challenges in

predicting, understanding, and managing the potentially adverse effects these materials could have on the environment and human lives.

## **Performance and Application of Novel Biocomposites**

This book describes how man-made litter, primarily plastic, has spread into the remotest parts of the oceans and covers all aspects of this pollution problem from the impacts on wildlife and human health to socio-economic and political issues. Marine litter is a prime threat to marine wildlife, habitats and food webs worldwide. The book illustrates how advanced technologies from deep-sea research, microbiology and mathematic modelling as well as classic beach litter counts by volunteers contributed to the broad awareness of marine litter as a problem of global significance. The authors summarise more than five decades of marine litter research, which receives growing attention after the recent discovery of great oceanic garbage patches and the ubiquity of microscopic plastic particles in marine organisms and habitats. In 16 chapters, authors from all over the world have created a universal view on the diverse field of marine litter pollution, the biological impacts, dedicated research activities, and the various national and international legislative efforts to combat this environmental problem. They recommend future research directions necessary for a comprehensive understanding of this environmental issue and the development of efficient management strategies. This book addresses scientists, and it provides a solid knowledge base for policy makers, NGOs, and the broader public.

## **Advances in Applications of Industrial Biomaterials**

Beginning with a general overview of nanocomposites, *Bionanocomposites: Integrating Biological Processes for Bio-inspired Nanotechnologies* details the systems available in nature (nucleic acids, proteins, carbohydrates, lipids) that can be integrated within suitable inorganic matrices for specific applications. Describing the relationship between architecture, hierarchy and function, this book aims at pointing out how bio-systems can be key components of nanocomposites. The text then reviews the design principles, structures, functions and applications

of bionanocomposites. It also includes a section presenting related technical methods to help readers identify and understand the most widely used analytical tools such as mass spectrometry, calorimetry, and impedance spectroscopy, among others.

## **The Complete Book on Biodegradable Plastics and Polymers (Recent Developments, Properties, Analysis, Materials & Processes)**

Amidst impending climate change and enhanced pollution levels around the globe, the need of the hour is to develop bio-based materials that are sustainable and possess comparable performance properties to their synthetic counterparts. In light of the aforementioned, numerous investigations are being conducted to identify, process, and create materials that are concurrently innocuous towards the environment and have superior properties. This book is a collection of such scientific articles that propagate novel ideas for the development of polymeric composite materials, which have application potential in numerous fields such as medicine, automobile, aviation, construction, etc. It also contains a pedagogical article that proposes some strategies to continue experimental research during pandemics. This book will provide readers a quick glance into recent developments regarding polymeric materials and will encourage them to propagate these research ideas further.

## **Hybrid Fiber Composites**

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,

bioclogging, 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.

## **Novel Biocomposite Engineering and Bio-Applications**

The Handbook of Composites From Renewable Materials comprises a set of 8 individual volumes that brings an interdisciplinary perspective to accomplish a more detailed understanding of the interplay between the synthesis, structure, characterization, processing, applications and performance of these advanced materials. The handbook covers a multitude of natural polymers/ reinforcement/ fillers and biodegradable materials. Together, the 8 volumes total at least 5000 pages and offers a unique publication. This 5th volume Handbook is solely focused on Biodegradable Materials. Some of the important topics include but not limited to: Rice husk and its composites; biodegradable composites based on thermoplastic starch and talc nanoparticles; recent progress in biocomposites of biodegradable polymer; microbial polyesters: production and market; biodegradable and bio absorbable materials for osteosynthesis applications; biodegradable polymers in tissue engineering; composites based on hydroxyapatite and biodegradable polylactide; biodegradable composites; development of membranes from bio-based materials and their applications; green biodegradable composites based on natural fibers; fully biodegradable all-cellulose

composites; natural fiber composites with bio-derivative and/or degradable polymers; synthetic biodegradable polymers for bone tissue engineering; polysaccharides as green biodegradable platforms for building-up electroactive composite materials; biodegradable polymer blends and composites from seaweeds; biocomposites scaffolds derived from renewable resources for bone tissue repair ; pectin-based composites; recent advances in conductive composites based on biodegradable polymers for regenerative medicine applications; biosynthesis of PHAs and their biomedical applications; biodegradable soy protein isolate/poly (vinyl alcohol) packaging films and biodegradability of bio-based polymeric materials in natural environment.

## **Food Nanotechnology**

This book addresses different aspects of green biocomposite manufacture from natural fibres and bioplastics, including the manufacturing procedures and the physical, mechanical, thermal and electrical properties of green biocomposites. Featuring illustrations and tables that maximize reader insights into the current research on biocomposites, it emphasises the role of green technology in the manufacture of biocomposites and analysis of properties of biocomposites for different applications. It is a valuable resource for researchers and scientists in industry wanting to understand the need for biocomposites in the development of green, biodegradable and sustainable products for different applications.

## **Handbook of Bioplastics and Biocomposites Engineering Applications**

Handbook of Bioplastics and Biocomposites Engineering Applications The 2nd edition of this successful Handbook explores the extensive and growing applications made with bioplastics and biocomposites for the packaging, automotive, biomedical, and construction industries. Bioplastics are materials that are being researched as a possible replacement for petroleum-based traditional plastics to make them more environmentally friendly. They are made from renewable resources and

may be naturally recycled through biological processes, conserving natural resources and reducing CO<sub>2</sub> emissions. The 30 chapters in the Handbook of Bioplastics and Biocomposites Engineering Applications discuss a wide range of technologies and classifications concerned with bioplastics and biocomposites with their applications in various paradigms including the engineering segment. Chapters cover the biobased materials; recycling of bioplastics; biocomposites modeling; various biomedical and engineering-based applications including optical devices, smart materials, cosmetics, drug delivery, clinical, electrochemical, industrial, flame retardant, sports, packaging, disposables, and biomass. The different approaches to sustainability are also treated. Audience The Handbook will be of central interest to engineers, scientists, and researchers who are working in the fields of bioplastics, biocomposites, biomaterials for biomedical engineering, biochemistry, and materials science. The book will also be of great importance to engineers in many industries including automotive, biomedical, construction, and food packaging.

## Applied Plastics Engineering Handbook

Biocomposites for High-Performance Applications: Current Barriers and Future Needs Towards Industrial Development focuses on future research directions that will make biocomposites a successful player in the field of high-strength structural applications. With contributions from eminent academic researchers and industrial experts who have first-hand experience on the advantages/disadvantages of biocomposites in their daily lives, the book examines the industrial development of biocomposite products, identifying the current barriers and their future industrial needs. Topics covered include: recent research activities from academia in the biocomposite research field, valuable thoughts and insights from biocomposite manufacturing industries, the strength and weaknesses of biocomposite products, and the practical issues that need to be addressed to reach the next level. Highlights the practical issues involved in biocomposites research. Contains contributions from eminent academic researchers and industrial experts. Discusses recent research activities from academia in the biocomposite research field, along with valuable

thoughts and insights from biocomposite manufacturing industries

## **Biocomposite and Synthetic Composites for Automotive Applications**

This handbook focuses on biopolymers for both environmental and biomedical applications. It shows recent advances in technology in all areas from chemical synthesis or biosynthesis to end use applications. These areas have not been covered in a single book before and they include biopolymers for chemical and biotechnological modifications, material structures, characterization, processing, properties, and applications. After the introduction which summarizes the importance of biopolymer in the market, the book covers almost all the topics related to polysaccharides, biofibers, bioplastics, biocomposites, natural rubber, gums, bacterial and blood compatible polymers, and applications of biopolymers in various fields.

## **The Handbook of Polyhydroxyalkanoates**

This book focuses on food, non-food, and industrial packaging applications of polymers, blends, nanostructured materials, macro, micro and nanocomposites, and renewable and biodegradable materials. It details physical, thermal, and barrier properties as well as sustainability, recycling, and regulatory issues. The book emphasizes interdis-

## **Biodegradable Polyesters**

A text to the advances and development of novel technologies in the production of high-value products from economically viable raw materials. Lignocellulosic Biorefining Technologies is an essential guide to the most recent advances and developments of novel technologies in the production of various high-value products from economically viable raw materials. Written by a team of experts on the topic, the book covers important topics specifically on production of economical and sustainable products such as various biofuels, organic acids, enzymes, biopigments, biosurfactants, etc. The book highlights the important aspects of

lignocellulosic biorefining including structure, function, and chemical composition of the plant cell wall and reviews the details about the various components present in the lignocellulosic biomass and their characterizations. The authors explore the various approaches available for processing lignocellulosic biomass into second generation sugars and focus on the possibilities of utilization of lignocellulosic feedstocks for the production of biofuels and biochemicals. Each chapter includes a range of clear, informative tables and figures, and contains relevant references of published articles. This important text: Provides cutting-edge information on the recent developments in lignocellulose biorefinery Reviews production of various economically important and sustainable products, such as biofuels, organic acids, biopigments, and biosurfactants Highlights several broad-ranging areas of recent advances in the utilization of a variety of lignocellulosic feedstocks Provides a valuable, authoritative reference for anyone interested in the topic Written for post-graduate students and researchers in disciplines such as biotechnology, bioengineering, forestry, agriculture, and chemical industry, Lignocellulosic Biorefining Technologies is an authoritative and updated guide to the knowledge about various biorefining technologies.

## **Handbook of Carbon-Based Filler(s) Reinforced PLA Biocomposites: Fundamentals to Applications**

Nanotechnology offers great potential to revolutionize conventional food science and the food industry. The use of nanotechnology in the food industry promises improved taste, flavor, color, texture, and consistency of foodstuffs and increased absorption and bioavailability of nutraceuticals. Food Nanotechnology: Principles and Applications examines the current state of nanoscale phenomena and processes, benefits and risks of nanotechnology. This work contains 18 chapters particularly focused on the design, production, and utilization of nanoparticles, with specific applications for the food industry. Through several studies, it has been proven that nanotechnology can offer distinct advantages over conventional methods in terms of functionality, targeted delivery of food bioactive compounds, improved food quality characteristics like texture, taste, sensory attributes and improved stability

in the gastrointestinal tract, and controlled release profiles. Features Offers clear and concise coverage on application of nanotechnology in nutrient delivery, food packaging, and pathogen/pesticide detection Addresses both the technological aspects of delivering nano-based food products and the societal implications that affect take-up Covers broad range of topics including nanoemulsification, electrospraying, nanocomposites, plasma processing, and nanosensors Discusses different formulation and preparation methods for loading food bioactive compounds Exploratory in nature, this book presents the latest of such data on all aspects of applications of nanotechnology in food systems. With its practical focus on the fabrication and application of nanotechnology in food, this book is a valuable resource for students, researchers, food process engineers.

## **Lignocellulosic Biorefining Technologies**

Marine Anthropogenic Litter

## **Biocomposites**

In the past, petroleum-based polymers were favoured because of low cost, better mechanical properties, and ease of production. The fast production of such polymers has a negative effect on the environment and the economy at large. As an example, the utilization of oil and gas has led to an increase in oil and natural gas prices. Therefore, there is a need for the production and development of biodegradable polymers for sustainable applications of plastics. The positive impact of biodegradable polymers is their ability to degrade in the natural environment. This book covers an in-depth discussion on the synthesis of polylactic acid (PLA) and its applications. Polylactic acid is fabricated from renewable sources such as corn, sorghum wheat and straw. However, there a need for high performance polymer materials in industrial applications, which prompted the researcher to produce biocomposites for advanced applications. In this book, carbon-based fillers incorporated in PLA matrix are discussed in relation to flame retardancy, mechanical properties, and thermal stability for the utilization of such composites in advanced applications.

## **Bioplastics and Biocomposites**

Green Biocomposites for Biomedical Engineering: Design, Properties, and Applications combines emergent research outcomes with fundamental theoretical concepts relevant to processing, properties and applications of advanced green composites in the field of biomedical engineering. The book outlines the design elements and characterization of biocomposites, highlighting each class of biocomposite separately. A broad range of biomedical applications for biocomposites is then covered, with a final section discussing the ethics and safety regulations associated with manufacturing and the use of biocomposites. With contributions from eminent editors and recognized authors around the world, this book is a vital reference for researchers in biomedical engineering, materials science and environmental science, both in industry and academia. Provides comprehensive information regarding current advances in the interdisciplinary field of eco-friendly green composite materials for biomedical applications Offers coverage of state-of-the-art physics-based advanced models used in composites Lists a broad range of characterization techniques and biomedical applications

## **Construction Biotechnology**

Towards more sustainable packaging with biodegradable materials! The combination of the continuously increasing food packaging waste with the non-biodegradable nature of the plastic materials that have a big slice of the packaging market makes it necessary to move towards sustainable packaging for the benefit of the environment and human health.

Sustainable packaging is the type of packaging that can provide to food the necessary protection conditions, but at the same time is biodegradable and can be disposed as organic waste to the landfills in order to biodegrade through a natural procedure. In this way, sustainable packaging becomes part of the circular economy. Sustainable Food Packaging Technology? deals with packaging solutions that use engineered biopolymers or biocomposites that have suitable physicochemical properties for food contact and protection and originate both from renewable or non-renewable resources, but in both cases are

compostable or edible. Modified paper and cardboard with increased protective properties towards food while keeping their compostability are presented as well. The book also covers natural components that can make the packaging functional, e.g., by providing active protection to the food indicating food spoilage. \* Addresses urgent problems: food packaging creates a lot of hard-to-recycle waste - this book puts forward more sustainable solutions using biodegradable materials \* State-of-the-art: ?Sustainable Food Packaging Technology? provides knowledge on new developments in functional packaging \* From lab to large-scale applications: expert authors report on the technology aspects of sustainable packaging

## **Green Biorenewable Biocomposites**

This unique multidisciplinary 8-volume set focuses on the emerging issues concerning synthesis, characterization, design, manufacturing and various other aspects of composite materials from renewable materials and provides a shared platform for both researcher and industry. The Handbook of Composites from Renewable Materials comprises a set of 8 individual volumes that brings an interdisciplinary perspective to accomplish a more detailed understanding of the interplay between the synthesis, structure, characterization, processing, applications and performance of these advanced materials. The Handbook comprises 169 chapters from world renowned experts covering a multitude of natural polymers/ reinforcement/ fillers and biodegradable materials. Volume 5 is solely focused on 'Biodegradable Materials'. Some of the important topics include but not limited to: Rice husk and its composites; biodegradable composites based on thermoplastic starch and talc nanoparticles; recent progress in biocomposites of biodegradable polymer; microbial polyesters: production and market; biodegradable and bioabsorbable materials for osteosynthesis applications; biodegradable polymers in tissue engineering; composites based on hydroxyapatite and biodegradable polylactide; biodegradable composites; development of membranes from biobased materials and their applications; green biodegradable composites based on natural fibers; fully biodegradable all-cellulose composites; natural fiber composites with bioderivative and/or

degradable polymers; synthetic biodegradable polymers for bone tissue engineering; polysaccharides as green biodegradable platforms for building up electroactive composite materials; biodegradable polymer blends and composites from seaweeds; biocomposites scaffolds derived from renewable resources for bone tissue repair; pectin-based composites; recent advances in conductive composites based on biodegradable polymers for regenerative medicine applications; biosynthesis of PHAs and their biomedical applications; biodegradable soy protein isolate/poly(vinyl alcohol) packaging films; and biodegradability of biobased polymeric materials in natural environment.

## Green Biocomposites

This second edition of a bestseller incorporates developments and advances in the world of thermoplastics with regard to material development, processing, properties, and applications. It includes separate sections on bioplastics and hybrid and inorganic polymers. As in the first edition, chapters are written in a review format and cover (a) historical development and commercialization; (b) polymerization and processing technologies; (c) structural and phase characteristics as they affect use properties; (d) additives effects on properties and applications, (e) blends and composites derived from these thermoplastics, and (f) applications.

## Biocomposites for High-Performance Applications

Keeping in mind the advantages of bio-based materials, this book focuses on the potential efficacy of different biocomposites procured from diverse natural resources and the preparation and processing of the biocomposites to be used for a variety of applications. Each chapter gives an overview on a particular biocomposite material and its processing and successful utilization for selected applications. The chapters summarize recently developed research on such topics as:

- Spider silk biocomposites
- Biogenic hydroxyapatite-based implant biocomposites
- Liquid crystals and cellulose derivatives biocomposites
- Bio-based epoxy resins
- Bio-based polyphenols and lignocellulosic fibers
- Wood-based

biocomposites • Flame retardant biocomposites • Biocomposites for industrial noise control • Cellulose-based bionanocomposites Each individual chapter also focuses on the knowledge and understanding of the interfaces manifested in these biocomposites systems and the optimization of different parameters for novel properties. In addition to this, the book also summarizes the recent developments made in the area of injection molding of biocomposites, chemical functionalization of natural fibers, processing of biocomposites, and their applications in the automotive and biomedical industries. A number of critical issues and suggestions for future work are discussed, underscoring the roles of researchers for the efficient development of biocomposite materials through value addition to enhance their use.

## **Sustainable Food Packaging Technology**

Collating otherwise hard-to-get and recently acquired knowledge in one work, this is a comprehensive reference on the synthesis, properties, characterization, and applications of this eco-friendly class of plastics. A group of internationally renowned researchers offer their first-hand experience and knowledge, dealing exclusively with those biodegradable polyesters that have become increasingly important over the past two decades due to environmental concerns on the one hand and newly-devised applications in the biomedical field on the other. The result is an unparalleled overview for the industrial chemist and materials scientist, as well as for developers and researchers in industry and academia alike.

## **Handbook of Composites from Renewable Materials, Biodegradable Materials**

Applied Plastics Engineering Handbook: Processing, Materials, and Applications, Second Edition, covers both the polymer basics that are helpful to bring readers quickly up-to-speed if they are not familiar with a particular area of plastics processing and the recent developments that enable practitioners to discover which options best fit their requirements. New chapters added specifically cover polyamides, polyimides, and polyesters. Hot topics such as 3-D printing and smart plastics are also

included, giving plastics engineers the information they need to take these embryonic technologies and deploy them in their own work. With the increasing demands for lightness and fuel economy in the automotive industry (not least due to CAFÉ standards), plastics will soon be used even further in vehicles. A new chapter has been added to cover the technology trends in this area, and the book has been substantially updated to reflect advancements in technology, regulations, and the commercialization of plastics in various areas. Recycling of plastics has been thoroughly revised to reflect ongoing developments in sustainability of plastics. Extrusion processing is constantly progressing, as have the elastomeric materials, fillers, and additives which are available. Throughout the book, the focus is on the engineering aspects of producing and using plastics. The properties of plastics are explained, along with techniques for testing, measuring, enhancing, and analyzing them. Practical introductions to both core topics and new developments make this work equally valuable for newly qualified plastics engineers seeking the practical rules-of-thumb they don't teach you in school and experienced practitioners evaluating new technologies or getting up-to-speed in a new field. Presents an authoritative source of practical advice for engineers, providing guidance from experts that will lead to cost savings and process improvements Ideal introduction for both new engineers and experienced practitioners entering a new field or evaluating a new technology Updated to include the latest technology, including 3D Printing, smart polymers, and thorough coverage of biopolymers and biodegradable plastics

## **Value-Added Biocomposites**

Recycled plastic biocomposites have attracted widespread attention from both researchers and manufacturers due to the significant improvements in their physico-mechanical, thermal, rheological, and barrier properties when compared to conventional materials, as well as their potential regarding commercialization and zero waste. Recycled Plastic Biocomposites presents the latest information on recycled polymers, textiles, pulp and paper, wood plastic, rubber waste plastic, and micro and nano effects of recycled plastic waste resources that have great potential

as reinforcement materials in composites because they are non-toxic, inexpensive, biodegradable, cost-effective, and available in large amounts. Recycled plastic biocomposites are now starting to be deployed in a broad range of materials applications due to their advantages over petroleum-based materials. Currently, there are no limits to the possibility of their applications. They also have exceptional sustainable and biodegradable properties when compared to conventional materials such as polymers and composites. Recycled Plastic Biocomposites reviews the latest research advances on recycled plastic-based biocomposites, including thermoplastic, thermoset, rubber, and foams. In addition, the book covers critical assessments on the economics of recycled plastic, including a cost-performance analysis that discusses its strengths and weaknesses as a reinforcement material. The huge potential applications of recycled plastic in industry are also explored in detail with respect to low cost, recyclable and biodegradable properties, and the way they can be applied to the automotive, construction, and packaging industries. The life cycles of both single and hybrid recycled plastic-based polymer composites and biocomposites are also discussed in detail. From the viewpoint of recycled plastic-based polymer composites, the book covers not only the well-known role of recycled polymers and composites, but also advanced materials produced from micro-, nano-, and pico-scale fillers that achieve better physical, mechanical, morphological, and thermal properties. This book will be an essential reference resource for academic and industrial researchers, materials scientists, and those working in polymer science and engineering, chemical engineering, manufacturing, and biocomposites. Places an emphasis on micro-, nano-, and pico-scale fillers that significantly improve properties. Discusses the most suitable fabrication methods, properties, and applications. Features critical assessments on the economics of recycled plastic, including a cost-performance analysis that reviews its strengths and weaknesses as a reinforcement material.

## **Handbook of Composites from Renewable Materials, Biodegradable Materials**

**Biocomposite and Synthetic Composites for Automotive Applications**

provides a detailed review of advanced macro and nanocomposite materials and structures, and discusses their use in the transport industry, specifically for automotive applications. This book covers materials selection, properties and performance, design solutions, and manufacturing techniques. A broad range of different material classes are reviewed with emphasis on advanced materials and new research pathways where composites can be derived from agricultural waste in the future, as well as the development and performance of hybrid composites. The book is an essential reference resource for those researching materials development and industrial design engineers who need a detailed understanding of materials usage in transport structures. Life Cycle Assessment (LCA) analysis of composite products in automotive applications is also discussed, and the effect of different fiber orientation on crash performance. Synthetic/natural fiber composites for aircraft engine fire-designated zones are linked to automotive applications. Additional chapters include the application and use of magnesium composites compared to biocomposites in the automotive industry; autonomous inspection and repair of aircraft composite structures via vortex robot technology and its application in automotive applications; composites in a three-wheeler (tuk tuk); and thermal properties of composites in automotive applications. Covers advanced macro and nanocomposites used in automotive structures Emphasizes materials selection, properties and performance, design solutions, and manufacturing techniques Features case studies of successful applications of biocomposites in automotive structures

## Green Biocomposites

The first volume of the "Handbook of Polyhydroxyalkanoates (PHA): Microbial Biosynthesis and Feedstocks" focusses on feedstock aspects, enzymology, metabolism and genetic engineering of PHA biosynthesis. It addresses better understanding the mechanisms of PHA biosynthesis in scientific terms and profiting from this understanding in order to enhance PHA biosynthesis in bio-technological terms and in terms of PHA microstructure. It further discusses making PHA competitive for outperforming established petrol-based plastics on industrial scale and

obstacles for market penetration of PHA. Aimed at professionals and graduate students in Polymer (plastic) industry, wastewater treatment plants, food industry, biodiesel industry, this book Covers the intracellular on-goings in PHA-accumulating bacteria Assesses diverse feedstocks to be used as carbon source for PHA production including current knowledge on PHA biosynthesis starting from inexpensive waste feedstocks Summarizes recent relevant results dealing with PHA production from various organic by-products Presents the key elements to understand and fine-tune the microstructure and sequence-controlled molecular architecture of PHA co-polyesters Discusses the use of CO-rich syngas, sourced from various organic waste materials, for PHA biosynthesis

## **Handbook of Composites from Renewable Materials, Nanocomposites**

Fiber-reinforced composites are exceptionally versatile materials whose properties can be tuned to exhibit a variety of favorable properties such as high tensile strength and resistance against wear or chemical and thermal influences. Consequently, these materials are widely used in various industrial fields such as the aircraft, marine, and automobile industry. After an overview of the general structures and properties of hybrid fiber composites, the book focuses on the manufacturing and processing of these materials and their mechanical performance, including the elucidation of failure mechanisms. A comprehensive chapter on the modeling of hybrid fiber composites from micromechanical properties to macro-scale material behavior is followed by a review of applications of these materials in structural engineering, packaging, and the automotive and aerospace industries.

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