

Preface

This book presents reviews of the latest research and practical applications in the field of novel industrial biomaterials. State-of-the-art research into the development of industrial biomaterials, their properties and practical applications in specific fields, including results already established, indicate great possible benefits. Biomaterials gained initial attention in medical applications, but their unique properties have provoked wider utilization in industry, especially in regard to aspects of environmental sustainability and protection. Industrial biomaterials can be classified by different aspects, but in general, they all pertain either to the substitution or complementation of existing materials in different industrial applications through consideration of the bioeconomy. Industrial biomaterials have been developed and studied within a wide swath of areas, ranging from the automotive and construction industries to the energy sector, food industry and waste recycling. Also, environmentally friendly synthesis, or green chemistry, of existing materials today is one of the foundations of the bioeconomy, imposed by the increased presence of numerous chemical pollutants. Many new methods have been studied for the purpose of decreasing pollution and providing added value simultaneously; using eco-friendly or degradable biomaterials in different products and consumer goods should be a cost-efficient way to achieve these goals.

Recent advances in the development of biomaterials for industrial applications are reviewed, along with possibilities for exchanging environmentally hazardous substances with environmentally friendly and degradable components in different sectors: the food industry, the automotive industry, energy production and renewable resources, environmental protection, etc. The authors are senior researchers in the various fields of material science, interlinked with different aspects of environmental preservation. Especially important is the incorporation of organic materials into different composites, to enable consumption of what would otherwise be waste material. Different materials, new production technologies and new application areas have all been reviewed. The food industry is an especially important sector for biopolymers, edible films and coatings in food production and biodegradable material classes. Construction industries are also very suitable for application of bio-based composites. One significant area of research in

transportation is related to biofuels, such as biodiesel based on organic constituents or green composites in marine applications. The use of biomass in energy supply chains shows promising prospects. Environmental protection aspects related to new nanoparticles, such as nano zero valent iron, are also reviewed.

Bio-based chemicals and bio-based packaging are among the most sought-after products nowadays. Plastic pollution has reached dangerous limits and chemical pollutants pose a serious threat to sustainable natural ecosystems in general. The pollution within our water and soil further transmits itself into plants, animals and, ultimately, humans. On the one side, green chemistry and green products promise a significant decrease in waste through fully or partially biodegradable eco-friendly materials. On the other side, waste management is also one of the tasks in the circular economy today, and a decrease in waste or the incorporation of existing waste into usable products is also studied in the broader field of industrial biomaterials. Application of biomass in composites and plastic materials is one of the most important developmental directions of industrial biomaterials. The significant advantage of such materials is their considerably lower cost in comparison with traditional materials of the same material classes. For example, wood waste, waste from the food and beverage industries, organic waste such as agricultural fibres (straw or flax) and plastic waste can be used for fabrication of new composites in construction industries, the furniture sector and many other areas. Such cost-efficient materials not only decrease the final product's price, but also significantly contribute to waste management and recycling.

Renewables are the major drivers of change nowadays, representing the cutting edge of research from a number of different aspects. There is significant potential for biomaterial application in the maritime shipping sector as well, from production of ship parts to its application as marine fuel. The shipping sector faces challenges related to reducing pollutant emissions and greenhouse gases. International regulatory bodies and national environmental agencies have issued rules and regulations that drastically limit these emissions. As a renewable source of energy, biodiesel is one option in reducing the emission of pollutants and Green House Gases (GHG), as well as achieving lower carbon intensity in the maritime shipping sector. Although practical experience in the use of biodiesel as a marine fuel is very scarce, some advantages over marine diesel fuels have already been noted, such as reduction of particulate emissions and a lack of adverse effects on marine diesel engines with blends up to 20%. Drawbacks, in general, include limited raw materials, higher production costs, which cannot compete with low quality heavy fuels for marine application, and, in particular, potential problems involving bacterial formations in tanks during the storage and degradation of certain rubber and elastomer compounds, since biodiesel acts as a solvent.

The food industry is perhaps the most interesting sector for industrial biomaterials. Biopolymers and edible films are important constituents in food packaging that aims to provide extended food preservation, as well as protection from decay and harmful external influences, such as antibacterial and antimicrobial effects.

Novel active packaging has been studied, and the future will provide various forms of both environmentally sustainable and human friendly packaging of food and beverages. Natural polymers can be biopolymers of marine origin or can be obtained from agricultural by-products. Edible and biodegradable biopolymers are mainly made of polysaccharides, lipids, and proteins. The main advantage of the biopolymers is that they are eco-friendly materials. Degradation of disposed conventional synthetic plastic materials derived from petroleum requires very long periods of time and is harmful to ecosystems.

The selection of edible/biodegradable materials in a food industry depends on the final product and can be used in various forms: edible films and coatings, packaging, antimicrobial and antioxidative protection, and others. Edible films and coatings are used to protect the freshness of meat, seafood, fruit, vegetables, grains, confectionery products and food mixtures that can be canned, deep frozen or kept in some other form of storage. Nowadays, nanoscale research pertaining to the detection of pathogens, active packaging, antimicrobial packaging, and the formation of different protective barriers has already started to improve food packaging. It may be possible, very soon, to use particles that are not organic to introduce diverse components such as colours and odours. Or they could be used as carriers for the controlled release of drugs or fungicides. New nanomaterials will also be used to improve mechanical properties and oxidation stability, to increase protection against gases, and possibly to increase the biodegradability of common biomaterials. Multi-functional intelligent packaging will be used as a substitute for traditional packing. Another very hot topic in food-related research is the possibility promised by the novel nanoparticles, nanocomposites and biopolymers for the design and creation of foods with new microscopic structures. The building blocks can be combined in various ways (e.g., microemulsions and nanofibers), thus enabling a wide range of new food structures.

Potential applications are great, and the products commercially realized to date strongly indicate that the field of industrial biomaterial development has already significantly contributed to both the circular economy and the bioeconomy, at the same time enabling the preservation and protection of natural resources. Innovations that have been established fall within a wide range of different important products, such as new composites made of recycled materials, biofuels, nanoparticles for the cleansing of ecosystems, and many others. A range of different industries can benefit from these novel bio-based materials, from the construction sector to wood processing industries, from different elements of our transportation industries up to green energy production. We believe that this book will provide young researchers and professionals alike with valuable insights into opportunities offered by these new materials and technologies, from the point of view of different professional disciplines—chemical engineering, marine engineering, fields of material science, and engineering in general—while emphasizing safety as an important input, motivating people to pursue further research and practical applications in this broad and multifaceted field of science.

This work is the result of the joint efforts of different companies and academic and research institutions, participating in the large international project, WIMB Tempus, 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 Tempus Programme of the European Union.

Bellaterra, Spain

Kotor, Montenegro

Bellaterra, Spain

Bellaterra, Spain

Kragujevac, Serbia

Kragujevac, Serbia

Zvornik, Bosnia and Herzegovina

Zvornik, Bosnia and Herzegovina

March 2017

Eva Pellicer

Danilo Nikolic

Jordi Sort

Maria Dolors Baró

Fatima Zivic

Nenad Grujovic

Radoslav Grujic

Svetlana Pelemis

Advances in Applications of Industrial Biomaterials

Pellicer, E.; Nikolic, D.; Sort, J.; Baró, M.; Zivic, F.;

Grujovic, N.; Grujic, R.; Pelemis, S. (Eds.)

2017, XII, 214 p. 75 illus., 62 illus. in color., Hardcover

ISBN: 978-3-319-62766-3