Industrial Applications of Natural Fibres
Structure, Properties and Technical Applications

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Industrial Applications
of Natural Fibres
Wiley Series
in
Renewable Resources

Series Editor

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Industrial Applications of Natural Fibres: Structure, Properties and Technical Applications
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Dedication

In recent years, natural fibres have become increasingly popular for use in industrial applications, e.g. as reinforcement for plastics. This approach is also of growing interest in light of the discussion about sustainability and environmental issues. These aspects are commonly not included in the regular university education for engineers and natural scientists. This book will examine the value-added chain of natural fibres in order to bring more detailed information about this complex topic to students as well as to industry and research. The book will enable the reader to gain a fundamental understanding of the sometimes complex transformation of a natural fibre to final technical product.

This book is dedicated to professional industrial researchers working in production processing (from fibre separation to the final product – textiles and composites), in fibre characterisation and in standardisation and harmonisation, to academics researching in the field of technical applications of natural fibres, as well as to postgraduates on specific courses and research projects in the above areas.
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Series Preface

Renewable resources, their use and modification are involved in a multitude of important processes with a major influence on our everyday lives. Applications can be found in the energy sector, chemistry, pharmacy, the textile industry, paints and coatings, to name but a few.

The area interconnects several scientific disciplines (agriculture, biochemistry, chemistry, technology, environmental sciences, forestry, . . .), which makes it very difficult to have an expert view on the complicated interaction. Therefore, the idea to create a series of scientific books, focussing on specific topics concerning renewable resources, has been very opportune and can help to clarify some of the underlying connections in this area.

In a very fast changing world, trends are not only characteristic of fashion and political standpoints, also science is not free from hypes and buzzwords. The use of renewable resources is again more important nowadays; however, it is not part of a hype or a fashion. As the lively discussions among scientists continue about how many years we will still be able to use fossil fuels, with opinions ranging from 50 years to 500 years, they do agree that the reserve is limited and that it is essential not only to search for new energy carriers but also for new material sources.

In this respect, renewable resources are a crucial area in the search for alternatives for fossil-based raw materials and energy. In the field of energy supply, biomass and renewable-based resources will be part of the solution, alongside other alternatives such as solar energy, wind energy, hydraulic power, hydrogen technology and nuclear energy.

In the field of material sciences, the impact of renewable resources will probably be even greater. Integral utilisation of crops and the use of waste streams in certain industries will grow in importance, leading to a more sustainable way of producing materials.

Although our society was much more (almost exclusively) based on renewable resources centuries ago, this disappeared in the Western world in the nineteenth century. Now it is time to focus again on this field of research. However, this should not mean a ‘retour à la nature’ but should be a multidisciplinary effort on a highly technological level to perform research into the development of new crops and products from renewable resources. This will be essential to guarantee a level of comfort for a growing number of people living on our planet. It is the challenge for the coming generations of scientists to develop more sustainable ways to create prosperity and to fight poverty and hunger in the world. A global approach is certainly favoured.

This challenge can only be dealt with if scientists are attracted to this area and are recognised for their efforts in this interdisciplinary field. It is therefore also essential that consumers recognise the fate of renewable resources in a number of products.

Furthermore, scientists do need to communicate and discuss the relevance of their work. The use and modification of renewable resources may not follow the path of the genetic engineering concept in view of consumer acceptance in Europe. In this regard, the series will certainly help to increase the visibility of the importance of renewable resources.
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Being convinced of the value of the renewables approach for the industrial world, as well as for developing countries, I was myself delighted to collaborate on this series of books focusing on different aspects of renewable resources. I hope that readers become aware of the complexity, the interaction and interconnections and the challenges of this field, and that they will help to communicate the importance of renewable resources.

I certainly wish to thank the people at John Wiley & Sons, Chichester, especially David Hughes, Jenny Cossham and Lyn Roberts, in seeing the need for such a series of books on renewable resources, for initiating and supporting it and for helping to carry the project through to the end.

Last but not least, I would like to thank my family, especially my wife Hilde and my children Paulien and Pieter-Jan, for their patience and for giving me the time to work on the series when other activities seemed to be more inviting.

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Series Editor Renewable Resources
June 2005
Preface

What makes natural fibres so fascinating? Representatives of different professional disciplines, like biologists, chemists, agronomical scientists, process engineers or preservation scientists, would certainly each answer this question quite differently, according to their own scientific interest and research. As a material scientist, I would like to describe my own perception and at the same time outline the leading thoughts of this book.

Material discoveries and material developments have in the history of mankind led to great progress in innovation, with far-reaching consequences for technology, economy and culture. The periodical division of prehistory and early history of mankind is mainly determined by the materials used in these periods (Stone Age, Bronze Age and Iron Age). Although the utilisation of natural fibres is verifiable in early archaeological cultures, it has not resulted in the naming of an epoch. There is no ‘natural fibre age’, although in history the usage of natural fibre has been quite varied and has repeatedly generated culturally significant innovations. Clothing textiles as well as technical textiles (e.g. nets) or composite materials (e.g. natural fibre compounded clay) are examples of such innovations. In this book these historical aspects of natural fibre usage are combined with possible future products.

In our progressively globalised world with unforeseeable demographic, economic and ecological challenges, management of resources and sustainability are increasingly becoming the focus of debate and discussion. The utilisation of materials is a key factor, and natural fibres in particular, being a natural resource, provide opportunities for technical innovation and sustainability.

The use of natural fibres, e.g. in technical applications, needs to be in line with the three essential pillars of sustainability – economy, ecology and society. To ensure that this remains so now and in the future, the worldwide raw material turnaround and its effects on the selection of materials must be critically examined on the basis of sustainability criteria.

The main argument against the industrial use of natural fibres is often that the quality of the fibres depends on the year in which they were grown. It is nevertheless possible to obtain fibres of consistent quality, as well as reliable data, enhancing the predictability of the properties of natural fibre products by using a quality management system that starts for plant fibres at the cultivation stage and that is based on reproducible proof of origin and harvesting parameters. This book will combine the different steps of processing, from agriculture, fibre separation and fibre processing to the manufacture of the final product. Each step will be linked to the fibre properties, the possibilities to characterise them, and how the different natural fibres will influence the product properties.

In order to understand why and how a natural fibre influences a product property, their chemical as well as structural qualities are thoroughly described. The fundamental understanding of the hierarchy and construction of natural fibre structures allow for a specific and selective design of natural fibre products.

However, natural fibres and their function in biological systems also offer an exceedingly interesting model for the development of biomimetic and bio-inspired materials. Here, also, a fundamental understanding of the functions enhances the transfer from biological system to technological appliance.