

SPRINGER BRIEFS IN MATERIALS

Khubab Shaker
Yasir Nawab

Lignocellulosic Fibers Sustainable Biomaterials for Green Composites



Springer

SpringerBriefs in Materials

Series Editors


Sujata K. Bhatia, University of Delaware, Newark, DE, USA

Alain Diebold, Schenectady, NY, USA

Juejun Hu, Department of Materials Science and Engineering, Massachusetts Institute of Technology, Cambridge, MA, USA

Kannan M. Krishnan, University of Washington, Seattle, WA, USA

Dario Narducci, Department of Materials Science, University of Milano Bicocca, Milano, Italy

Suprakas Sinha Ray , Centre for Nanostructures Materials, Council for Scientific and Industrial Research, Brummeria, Pretoria, South Africa

Gerhard Wilde, Altenberge, Nordrhein-Westfalen, Germany

The SpringerBriefs Series in Materials presents highly relevant, concise monographs on a wide range of topics covering fundamental advances and new applications in the field. Areas of interest include topical information on innovative, structural and functional materials and composites as well as fundamental principles, physical properties, materials theory and design. SpringerBriefs present succinct summaries of cutting-edge research and practical applications across a wide spectrum of fields. Featuring compact volumes of 50 to 125 pages, the series covers a range of content from professional to academic. Typical topics might include

- A timely report of state-of-the art analytical techniques
- A bridge between new research results, as published in journal articles, and a contextual literature review
- A snapshot of a hot or emerging topic
- An in-depth case study or clinical example
- A presentation of core concepts that students must understand in order to make independent contributions

Briefs are characterized by fast, global electronic dissemination, standard publishing contracts, standardized manuscript preparation and formatting guidelines, and expedited production schedules.

More information about this series at <https://link.springer.com/bookseries/10111>

Khubab Shaker · Yasir Nawab

Lignocellulosic Fibers

Sustainable Biomaterials for Green
Composites

 Springer

Khubab Shaker
Department of Materials
National Textile University
Faisalabad, Pakistan

Yasir Nawab 
Department of Textile Engineering
National Textile University
Faisalabad, Pakistan

ISSN 2192-1091

SpringerBriefs in Materials

ISBN 978-3-030-97412-1

<https://doi.org/10.1007/978-3-030-97413-8>

ISSN 2192-1105 (electronic)

ISBN 978-3-030-97413-8 (eBook)

© The Author(s), under exclusive license to Springer Nature Switzerland AG 2022

This work is subject to copyright. All rights are solely and exclusively licensed by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, expressed or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

*This work is dedicated to the researchers,
working on sustainable developments,
for greening the world,
into a place to live,
for the future generations.*

Preface

The developments in petroleum-based materials and increased dependency on their products have not only resulted into quick depletion of these resources but also raised environmental concerns. The planet earth is under pressure of a huge volume of waste generated as a result of irresponsible production and consumption. A lot of efforts are underway to address these challenges, one of which is the use of sustainable and biodegradable materials. This book is an effort to review the non-conventional lignocellulosic fibers obtained from different plant sources. It also explores the properties of these fibers and their potentials to replace the synthetic fibers as sustainable reinforcement material for Green Composites. Lignocellulosic fibers from leaf, seed, fruit, bast, grass, agrowaste and wood sources are discussed in brief. The chemical composition and properties of these fibers are also compared, to facilitate in material selection. We believe that this book will be essential reading for students and professionals working in the domain of lignocellulosic fibers and green composites.

Faisalabad, Pakistan

Khubab Shaker
Yasir Nawab

Contents

1 Green Composite Solutions	1
1.1 Need for Green Composites	1
1.1.1 Advantages of Green Composites	2
1.2 Constituents of a Green Composite	2
1.2.1 Reinforcements	2
1.2.2 Matrices	3
1.3 Fabrication Techniques	4
1.3.1 Hand Layup	4
1.3.2 Compression Molding	4
1.3.3 Injection Molding	5
1.3.4 Resin Infusion/Vacuum Bagging	5
1.4 Biodegradation of Green Composites	7
1.5 Key Challenges	8
1.6 Applications	8
References	8
2 Lignocellulosic Fiber Structure	11
2.1 Introduction	11
2.2 Chemical Composition of Lignocellulosic Fibers	12
2.2.1 Cellulose	13
2.2.2 Hemicellulose	14
2.2.3 Lignin	15
2.3 Structure of Lignocellulosic Fibers	16
2.4 Lignocellulosic Fibers from Secondary Plants	18
References	19
3 Fruit, Seed and Leaf Fibers	21
3.1 Introduction	21
3.2 Fruit and Seed Fibers	22
3.2.1 Kapok	22
3.2.2 Brazil Nut	22
3.2.3 Coconut	23