

Maria Mathew · Rony Rajan Paul ·
Ann Rose Abraham · A. K. Haghi

Electrospun Porous Nanofibers

An Introduction

Synthesis Lectures on Emerging Engineering Technologies

This series publishes short books on current engineering technologies that are gaining prominence, as well as promising technologies that are being developed, for an audience of researchers, advanced students, engineers and other professionals, and entrepreneurs.

Maria Mathew · Rony Rajan Paul ·
Ann Rose Abraham · A. K. Haghi

Electrospun Porous Nanofibers

An Introduction

Maria Mathew
Department of Chemistry
National Institute of Technology Calicut
Calicut, Kerala, India

Ann Rose Abraham
Department of Physics
Sacred Heart College
Thevara, Kerala, India

Rony Rajan Paul
Department of Chemistry
CMS College Kottayam (Autonomous)
Kottayam, Kerala, India

A. K. Haghi
Institute of Molecular Chemistry
Coimbra University
Coimbra, Portugal

ISSN 2381-1412 ISSN 2381-1439 (electronic)
Synthesis Lectures on Emerging Engineering Technologies
ISBN 978-3-031-86105-5 ISBN 978-3-031-86106-2 (eBook)
<https://doi.org/10.1007/978-3-031-86106-2>

© The Editor(s) (if applicable) and The Author(s), under exclusive license to Springer
Nature Switzerland AG 2025

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

If disposing of this product, please recycle the paper.

Contents

1	Introduction to Electrospinning of Nanofibers	1
	Introduction	1
	Historical Background	2
	Basic Principle of Electrospinning	3
	Electrospinning Parameters	3
	Processing Parameters	4
	Solution Parameters	5
	Environmental Parameters	7
	Different Modes of Electrospinning	8
	<i>Needle-Based</i> Electrospinning	9
	Needleless Electrospinning	11
	Applications of Electrospun Nanofibrous Membranes	12
	Limitations and Challenges	13
	References	14
2	Applications of Electrospun Nanofibers	19
	Introduction	19
	Biomedical Applications	20
	Environmental Applications	23
	Textile Applications	26
	Energy Applications	29
	Conclusion	31
	References	32
3	Electrospun Nanofiber Membranes	35
	Introduction	35
	Structure and Properties of Nanofiber Membranes	35
	Porosity and Pore Size Distribution	36
	Mechanical Properties	36
	Electrospun Nanofiber Membranes with Different Structures	38

Core–Shell Fibers	38
Porous Nanofibers	40
Hollow Nanofibers	42
Membrane Applications	42
Biomedical Implants	43
Food Packaging Membranes	44
Biosensors	46
References	47
4 Electrospun Nanofiber Composites	51
Introduction	51
Polymer Matrix Composites (PMCs)	52
Reinforcement of Polymer Matrices	52
Enhancement of Mechanical Properties	53
Functionalization for Specific Applications	55
Inorganic Nanofiller Reinforced Composites	56
Carbon Nanotubes (CNTs)	57
Metal-Oxide Nanoparticles	58
Hybrid Nanocomposites	59
Applications of Nanofiber Composites	60
Structural Materials	60
Tissue Engineering Scaffolds	61
Electronics and Optoelectronics	62
Conclusion	64
References	64