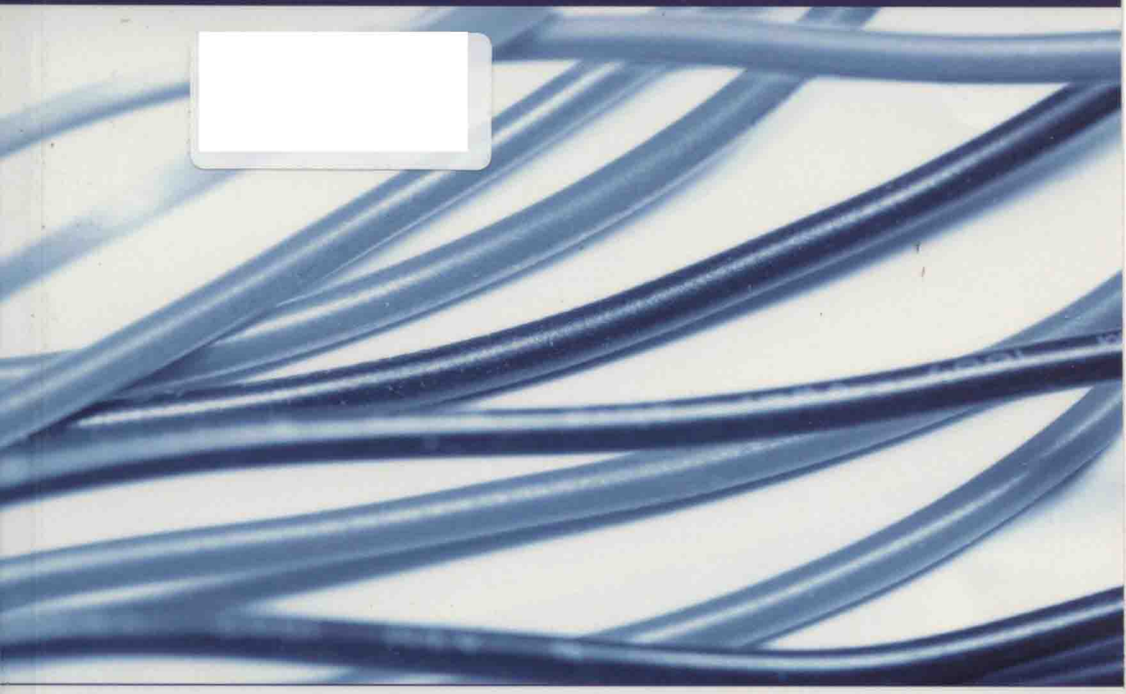

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Fibre generators, Fibre morphologies and properties

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Impressum / Imprint
Bibliografische Information der Deutschen Nationalbibliothek: Die Deutsche Nationalbibliothek verzeichnet diese Publikation in der Deutschen Nationalbibliografie; detaillierte bibliografische Daten sind im Internet über http://dnb.d-nb.de abrufbar.

Bibliographic information published by the Deutsche Nationalbibliothek: The Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data are available in the Internet at http://dnb.d-nb.de.

Coverbild / Cover image: www.ingimage.com

Verlag / Publisher:
LAP LAMBERT Academic Publishing
ist ein Imprint der / is a trademark of
AV Akademikerverlag GmbH & Co. KG
Heinrich-Böcking-Str. 6-8, 66121 Saarbrücken, Deutschland / Germany
Email: info@lap-publishing.com

Herstellung: siehe letzte Seite /
Printed at: see last page
ISBN: 978-3-659-31906-8

Zugl. / Approved by: PhD, Geelong, Deakin University, 2010

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Dedication

This work is dedicated to my parents, Mr. Ximing Niu and Mrs. Guihua Zhang, and my wife, Hua Zhou, and my son Zichen Niu, for their endless love and support!

Acknowledgements

A lot of people have supported my research work. First and foremost, I would like to express my sincerest gratitude to my supervisor, Professor Tong Lin, for his indefatigable guidance and encouragement from the first day of my study. His support is so important that I would not have accomplished this book without it.

I also would like to thank another supervisor, Professor Xungai Wang, for giving me such a marvellous opportunity to study at Deakin and lots of helpful suggestions to my works.

I would like to thank Dr Jian Fang and Mr Xin Wang for assisting my project and for providing the opportunity for me to contribute to their projects, which has resulted in joint publications.

My special thanks go to Mr. Chris Hurren, Mr. Graeme Keating, and Dr. Xin Liu. Their knowledge and patience were very helpful to me. Without their help I couldn't have obtained many of my results.

I also thank Dr. Wendy Tian and Dr. Zongli Xie from CSIRO for the DSC and BET analysis, Mr. Rod Mackie and Mr. Finlay Shanks from Monash University for XRD and Raman analysis, Dr. Robert Jones from La Trobe University for XPS analysis, my fellow researchers Dr Yan Zhao and Miss Yaqiong Zhou for TG and mechanical analysis, and visiting student Mr Yuhua Xue from Zhejiang University for some of the TEM analysis.

I wish to thank all my friends in the Centre for Material and Fibre Innovation at Deakin University. I really enjoyed the wonderful time with them.

Finally, I wish to express my gratitude to my dear parents and my wife and lovely son for their support and trust for my study and life.

Abstract

Electrospinning is very useful method to produce polymeric nanofibres with controlled fibre fineness and morphology. Electrospun nanofibre membranes can be used in diverse applications due to their porous structure, high surface area and tuneable functionality. In spite of big improvements in this technology, some problems associated with electrospinning still remain unsolved. Needle electrospinning typically has a low production rate, which has been the main obstacle to the commercialisation of electrospun nanofibres. Needleless electrospinning has much higher nanofibre productivity than needle electrospinning. However, how the spinneret shape affects the electric field profile in needleless electrospinning, the electrospinning process, fibre morphology and productivity has not been fully elucidated. Sylgard 184 has been regarded as a highly useful polydimethylsiloxane (PDMS) elastomer, but the successful electrospinning of Sylgard 184 elastomer remains a challenge, because its curing process requires 48 hours at room temperature or 10 hours at 60 °C. Will the core-shell electrospinning technique be able to produce PDMS fibres? Electrospun carbon nanofibres, showing porous structure and large surface area, find good applications in catalysis, filtration, energy storage, and battery. However, there has been no report on the morphology and properties of carbon nanofibres from bicomponent polymer nanofibres. How to use side-by-side nanofibres to produce inter-bonded fibrous network has not yet been demonstrated. Ag containing nanofibres endow the fibres with good catalytic and antivirus properties. However, the controlled growth of Ag crystals on electrospun nanofibres hasn't been reported. It remains unclear if the Ag nanoparticles within PAN nanofibres can be induced to undergo an *in-situ* reduction so that Ag can be formed just on the surface of PAN fibres.

The objectives of this project are:

a) to elucidate the influence of spinneret shape on needleless electrospinning process, fibre morphology and productivity;
b) to produce Sylgard 184 PDMS fibres from a co-electrospinning process and examine the influences of post-electrospinning treatment on the resultant PDMS fibre morphology and elasticity;
c) to produce inter-connected carbon nanofibres using side-by-side co-electrospinning followed by carbonisation treatment and examine their properties and electrochemical performances; and
d) to produce PAN core-Ag sheath electrospun fibres through a post-electrospinning treatment, and examine the influence of treatment conditions on the morphology of Ag sheath layer.

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