WOODHEAD PUBLISHING SERIES IN TEXTILES

Handbook of medical textiles

Edited by V. T. Bartels

The Textile Institute

WP
WOODHEAD PUBLISHING

Handbook of medical textiles

The Textile Institute and Woodhead Publishing

The Textile Institute is a unique organisation in textiles, clothing and footwear. Incorporated in England by a Royal Charter granted in 1925, the Institute has individual and corporate members in over 90 countries. The aim of the Institute is to facilitate learning, recognise achievement, reward excellence and disseminate information within the global textiles, clothing and footwear industries.

Historically, The Textile Institute has published books of interest to its members and the textile industry. To maintain this policy, the Institute has entered into partnership with Woodhead Publishing Limited to ensure that Institute members and the textile industry continue to have access to high calibre titles on textile science and technology.

Most Woodhead titles on textiles are now published in collaboration with The Textile Institute. Through this arrangement, the Institute provides an Editorial Board which advises Woodhead on appropriate titles for future publication and suggests possible editors and authors for these books. Each book published under this arrangement carries the Institute's logo.

Woodhead books published in collaboration with The Textile Institute are offered to Textile Institute members at a substantial discount. These books, together with those published by The Textile Institute that are still in print, are offered on the Woodhead web site at: www.woodheadpublishing.com. Textile Institute books still in print are also available directly from the Institute's website at: www.textileinstitutebooks.com.

A list of Woodhead books on textile science and technology, most of which have been published in collaboration with The Textile Institute, can be found towards the end of the contents pages.

Woodhead Publishing Series in Textiles: Number 100

Handbook of medical textiles

Edited by
V. T. Bartels

The Textile Institute

Oxford Cambridge Philadelphia New Delhi

Published by Woodhead Publishing Limited in association with The Textile Institute
Woodhead Publishing Limited,
80 High Street, Sawston, Cambridge CB22 3HJ, UK
www.woodheadpublishing.com

Woodhead Publishing, 1518 Walnut Street, Suite 1100, Philadelphia, PA 19102-3406, USA

Woodhead Publishing India Private Limited, G-2, Vardaan House, 7/28 Ansari Road,
Daryaganj, New Delhi – 110002, India
www.woodheadpublishingindia.com

First published 2011, Woodhead Publishing Limited

British Library Cataloguing in Publication Data
A catalogue record for this book is available from the British Library.

Library of Congress Control Number: 2011934929

ISBN 978-1-84569-691-7 (print)
ISBN 978-0-85709-369-1 (online)
ISSN 2042-0803 Woodhead Publishing Series in Textiles (print)
ISSN 2042-0811 Woodhead Publishing Series in Textiles (online)

The publisher's policy is to use permanent paper from mills that operate a sustainable forestry policy, and which has been manufactured from pulp which is processed using acid-free and elemental chlorine-free practices. Furthermore, the publisher ensures that the text paper and cover board used have met acceptable environmental accreditation standards.

Typeset by RefineCatch Limited, Bungay, Suffolk
Printed by TJI Digital, Padstow, Cornwall, UK

Cover image © Fotolia

Contents

Contributor contact details *xiii*
Woodhead Publishing Series in Textiles *xvii*
Preface *xxiii*

Part I Types and properties of medical textiles 1

1 Modern textiles and biomaterials for healthcare 3
S. PETRULYTE and D. PETRULIS, Kaunas University of Technology, Lithuania

1.1 Introduction 3
1.2 The role of textile structures and biomaterials in healthcare 4
1.3 Types of textiles and biomaterials for medical applications 5
1.4 Key properties of medical textile products 9
1.5 Contacting behaviour and transmission phenomenon of medical-based textiles 14
1.6 Engineering stability and compactness in medical textile systems 16
1.7 Advanced examples of research and product development 18
1.8 Future of medical textiles and products 22
1.9 Sources of further information and advice 29
1.10 Acknowledgement 29
1.11 References 29

2 Hi-tech textiles for interactive wound therapies 38
S. RAJENDRAN and S. C. ANAND, University of Bolton, UK

2.1 Introduction 38
2.2 Wounds 39
2.3 Wound dressings 43
2.4 Venous leg ulcers and their treatment 52
2.5 Wound dressing structures 67
2.6 Conclusions 74
2.7 References 75

3 Reusable medical textiles 80
H. M. Zins, Howard M. Zins Associates LLC, USA
3.1 Introduction 80
3.2 The role of reusable medical textiles: a historical perspective 80
3.3 Advantages of reusable textiles 81
3.4 Types of reusable textiles used for medical applications 86
3.5 Processing procedures 94
3.6 Healthcare costs 97
3.7 Future trends 100
3.8 Conclusions 102
3.9 References 102

4 Nonwoven materials and technologies for medical applications 106
J. R. Ajmeri and C. Joshi Ajmeri, Sarvajanik College of Engineering and Technology, India
4.1 Introduction 106
4.2 Key issues of nonwovens 107
4.3 Main types of nonwovens and technologies for medical applications 111
4.4 Strengths and limitations of nonwoven materials (NMs) for medical applications 116
4.5 Applications of nonwovens in medicine 117
4.6 Future trends 125
4.7 Sources of further information and advice 126
4.8 References 126

5 Textiles for implants and regenerative medicine 132
M. Doser and H. Planck, German Institutes for Textile and Fiber Research Denkendorf (DITF), Germany
5.1 Introduction 132
5.2 Textiles as implants 133
5.3 Textiles for regenerative medicine 142
5.4 Testing of implants and materials for regenerative medicine 149
5.5 Sources of further information 150
5.6 References 150

6 Textiles with cosmetic effects 153
R. Mathis and A. Mehling, BASF Personal Care and Nutrition GmbH, Germany
6.1 Introduction 153
6.2 Application and release technologies 154
6.3 Functionalities of cosmetotextiles and performance testing 160
6.4 Safety evaluation and other regulatory aspects 169

6.5 Future trends 170
6.6 References 171

7 Drug-releasing textiles 173
U. S. Toti, S. G. Kumbar, C. T. Laurencin, R. Mathew and D. Balasubramaniam, University of Connecticut Health Center, USA

7.1 Introduction 173
7.2 Classification of drug-releasing textiles 175
7.3 Fabrication and characterization 176
7.4 Applications of drug-releasing textiles 184
7.5 Conclusions 189
7.6 Future trends 190
7.7 Acknowledgments 191
7.8 Sources of further information and advice 191
7.9 References 191

8 Medical textiles and thermal comfort 198
G. Song, University of Alberta, Canada, W. Cao, California State University, Northridge, USA and R. M. Cloud, Baylor University, USA

8.1 Fundamentals of thermal comfort 198
8.2 Healthcare workers and patients in the hospital environment 201
8.3 Thermal comfort of medical textiles: surgical gowns 205
8.4 Evaluation and testing of thermal properties for medical textiles 212
8.5 Future trends 214
8.6 Sources of further information and advice 215
8.7 References 215

Part II Textiles and the skin 219

9 Contact sensations of medical textiles on the skin 221
V. T. Bartels, Bartels Scientific Consulting GmbH, Germany

9.1 Introduction 221
9.2 Skin contact sensations 223
9.3 Textile properties influencing skin contact sensations 227
9.4 Examples of applications 236
9.5 Future trends 241
9.6 Conclusions 242
9.7 Sources of further information 243
9.8 Acknowledgment 243
9.9 References 244

10 Mechanical skin irritations due to textiles 248
U. Wollina, Academic Teaching Hospital Dresden-Friedrichstadt, Germany
10.1 Introduction 248
10.2 Human skin 248
10.3 Skin irritation 250
10.4 Skin responses to mechanical forces 251
10.5 Measurement of irritating mechanical factors 254
10.6 Factors causing a textile to be mechanically irritating 258
10.7 References 263

11 Allergies caused by textiles 267
R. Weckmann, Dr Rainer Weckmann Textile Consulting, Germany
11.1 Introduction 267
11.2 Types of allergies 267
11.3 Main types of allergies caused by textiles 268
11.4 Ways to minimise or avoid allergies caused by textiles 270
11.5 Testing for allergy-causing substances 275
11.6 Medical textile applications 277
11.7 Sources of further information and advice 278
11.8 References 278

12 Biofunctional textiles based on cellulose and their approaches for therapy and prevention of atopic eczema 280
U-C. Hipler and C. Wiegand, Friedrich Schiller University of Jena, Germany
12.1 Introduction 280
12.2 The role of microbial infections in atopic dermatitis 281
12.3 Skin barrier function and increased sensitivity to irritants 283
12.4 Lyocell fibers for antimicrobial therapy 284
12.5 SeaCell® textiles for antimicrobial therapy 286
12.6 Future trends and conclusions 289
12.7 References 290

Part III Textiles for hygiene 295

13 Infection prevention and control and the role of medical textiles 297
R. James, University of Nottingham, UK
13.1 Introduction 297
13.2 Superbugs and healthcare-associated infections (HAIs) 303

13.3 Principles and practice of infection prevention and control in hospitals 306
13.4 The role of textiles in infection prevention and control 309
13.5 Future challenges 310
13.6 A holistic approach to preventing infections 312
13.7 Sources of further information 313
13.8 References 313

14 Absorbent products for personal health care and hygiene 316
F. Wiesemann and R. Adam, Procter & Gamble Service GmbH, Germany
14.1 Introduction 316
14.2 Different types of absorbent products for personal health and hygiene 316
14.3 Key issues of absorbent hygiene products 319
14.4 Testing of absorbent hygiene products 325
14.5 Application example: diapers – adapting products from premature babies to toilet training 329
14.6 Future trends 330
14.7 Sources of further information and advice 333
14.8 Acknowledgements 333
14.9 References 333

15 Bio-functional textiles 336
S. Liu, University of Manitoba, Canada and G. Sun, University of California, Davis, USA
15.1 Introduction 336
15.2 Types of bio-functional textiles 336
15.3 Evaluation of bio-functional effects and safety 343
15.4 Applications of bio-functional textiles 344
15.5 Manufacturing of bio-functional textiles 346
15.6 Future trends 353
15.7 Sources of further information 354
15.8 References 354

16 Hospital laundries and their role in medical textiles 360
J. Beringer and J. Kurz, Hohenstein Institutes, Germany
16.1 Introduction 360
16.2 Key issues of hospital laundries 361
16.3 Impact of hospital laundries on the hygiene of medical textiles 369
16.4 Testing and quality control of hygienic properties in hospital laundries 378

16.5 State of the art in hospital laundries 381
16.6 Future trends 382
16.7 Sources of further information and advice 382
16.8 Further reading 382
16.9 Appendix: additional information 383

17 Odour control of medical textiles 387
R. H. McQueen, University of Alberta, Canada
17.1 Introduction 387
17.2 Measurement of odour 388
17.3 Key issues of odour control in medical applications 396
17.4 Control of odour with textiles 401
17.5 Future trends 410
17.6 Acknowledgement 411
17.7 References 411

Part IV Medical textile case studies and applications 417

18 Textiles for medical filters 419
W. Zhong, University of Manitoba, Canada
18.1 Introduction 419
18.2 Key issues of medical filters 419
18.3 Application of hollow fiber bioreactors 423
18.4 Evaluation and characterization of medical filters 425
18.5 Future trends 430
18.6 References 431

19 Textiles for patient heat preservation during operations 434
U. Möhring, D. Schwabe and S. Hanus, Textile Research Institute Thuringia-Vogtlande. V., Germany
19.1 Key issues and importance of preventing cold stress in patients during operations 434
19.2 Main types of textiles used to maintain patient temperature during operations 435
19.3 Applications of textiles in maintaining patient temperature 435
19.4 Future trends 437
19.5 Sources of further information and advice 440
19.6 References 441

20 Evaluation of occupational clothing for surgeons: achieving comfort and avoiding physiological stress through suitable gowns 443
W. Nocker, Consultant, Germany

20.1 Historical background 443
20.2 Surgical gowns 444
20.3 Influences on wear properties 444
20.4 Elements of comfort 447
20.5 Evaluation of parameters relevant for comfortable textiles 447
20.6 Sweating as an effect of physiological stress 448
20.7 Controlled wear tests 451
20.8 Purchasing criteria 456
20.9 Conclusions and recommendations 458
20.10 References 459

21 Occupational clothing for nurses: combining improved comfort with economic efficiency 461
M. Walz, Eschler Textil GmbH, Germany

21.1 Introduction 461
21.2 Materials and methods 463
21.3 Cleanliness 464
21.4 Improving comfort in nurses' occupational clothing 464
21.5 Improving durability of nurses' clothing in industrial laundering processes 468
21.6 Possible savings in resources, washing and drying, durability and nosocomial infections 475
21.7 Applications of knitted microfibre fabrics 476
21.8 Future trends 477
21.9 Sources of further information and advice 479
21.10 Acknowledgement 479
21.11 References 480

22 Medical bandages and stockings with enhanced patient acceptance 481
C. Rotsch, H. Oschatz, D. Schwabe, M. Weiser and U. Möhring, Textile Research Institute Thuringia-Vogtlande., V. Germany

22.1 Introduction 481
22.2 Key issues and the role of medical bandages and stockings 482
22.3 Improving patient acceptance of medical bandages and stockings 492
22.4 Conclusions 500
22.5 References 501

23 Superabsorbents and their medical applications 505
G. Bartkowiak, Central Institute for Labour Protection – National Research Institute, Poland and I. Frydrych, Central Institute for Labour Protection – National Research Institute, Poland and Technical University of Lodz, Poland
23.1 Introduction 505
23.2 Methods of obtaining superabsorbent polymers and their chemical structure 506
23.3 Forms of superabsorbents and their properties 510
23.4 Development stages of superabsorbent materials according to appropriate patents 516
23.5 Applications of superabsorbents in medicine 518
23.6 Applications of superabsorbents in hygiene products and medical textiles 520
23.7 Applications of superabsorbents for comfort improvement 525
23.8 Ergonomic tests 534
23.9 Application of superabsorbent materials in half masks 542
23.10 Conclusions 543
23.11 References 544

24 Nanofibrous textiles in medical applications 547
L. Van der Schueren and K. De Clerck, Ghent University, Belgium
24.1 Introduction 547
24.2 Nanofibrous textiles 547
24.3 Applications of nanofibres in the medical field 551
24.4 Future trends 559
24.5 Sources of further information and advice 560
24.6 References 560

Index *567*

Contributor contact details

(* = main contact)

Editor and Chapter 9

V. T. Bartels
Bartels Scientific Consulting GmbH
Heidestrasse 26
74336 Brackenheim
Germany
E-mail: vt.bartels@bartels-scientific.de

Chapter 1

S. Petrulyte* and D. Petrulis
Department of Textile Technology
Kaunas University of Technology
Studentu 56
LT-51424
Kaunas
Lithuania
E-mail: salvinija.petrulyte@ktu.lt;
donatas.petrulis@ktu.lt

Chapter 2

S. Rajendran* and S. C. Anand
Institute for Materials Research and Innovation
University of Bolton
Bolton
BL3 5AB
UK
E-mail: S.Rajendran@bolton.ac.uk

Chapter 3

H. M. Zins
Howard M. Zins Associates LLC
810 Rotherham Drive
Ballwin
MO 63011
USA
E-mail: hmzins@yahoo.com

Chapter 4

J. R. Ajmeri* and C. Joshi Ajmeri
Department of Textile Technology
Sarvajanik College of Engineering and Technology
Dr R. K. Desai Marg
Athwalines
Surat – 395 001
Gujarat
India
E-mail: jajmeri@hotmail.com

Chapter 5

M. Doser* and H. Planck
Department of Biomedical Engineering
Institute of Textile Technology and Process Engineering (ITV)
German Institutes for Textile and Fiber Research Denkendorf (DITF)
Koerschtalstrasse 26
73770 Denkendorf
Germany
E-mail: Michael.doser@itv-denkendorf.de

Chapter 6

R. Mathis*
BASF Personal Care and Nutrition GmbH
Rheinpromenade 1
40789 Monheim
Germany
E-mail: Raymond.Mathis@Cognis.com

A. Mehling
BASF Personal Care and Nutrition GmbH
Henkelstrasse 67
40551 Düsseldorf
Germany
E-mail: Annette.Mehling@Cognis.com

Chapter 7

U. S. Toti, S. G. Kumbar*, C. T. Laurencin, R. Mathew and D. Balasubramaniam
Department of Orthopaedic Surgery
Department of Chemical, Materials and Biomolecular Engineering
University of Connecticut Health Center
263 Farmington Avenue
Farmington
CT 06030
USA
E-mail: Kumbar@uchc.edu

Chapter 8

G. Song*
Department of Human Ecology
University of Alberta
Edmonton, AB
T6G 2N1
Canada
E-mail: guowen.song@ualberta.ca

W. Cao
Department of Family and Consumer Sciences
California State University – Northridge
18111 Nordhoff Street
Northridge, CA
91330-8309
USA
E-mail: wei.cao@csun.edu

R. M. Cloud
Family and Consumer Sciences
Baylor University
One Baylor Place 97346
Waco, TX
76798-7346
USA
E-mail: rinn_cloud@baylor.edu

Chapter 10

U. Wollina
Department of Dermatology and Allergology
Hospital Dresden-Friedrichstadt
Academic Teaching Hospital of the Technical University of Dresden
Friedrichstrasse 41
01067 Dresden
Germany
E-mail: wollina-uw@khdf.de

Chapter 11

R. Weckmann
Dr Rainer Weckmann Textile Consulting
Sulzbergring 14
74336 Brackenheim
Germany
E-mail: dr.weckmann@web.de

Chapter 12

U-C. Hipler* and C. Wiegand
Department of Dermatology and Allergology
Friedrich Schiller University Hospital Jena
Erfurter Str. 35
07740 Jena
Germany
E-mail: Christina.Hipler@med.uni-jena.de

Chapter 13

R. James
Centre for Healthcare Associated Infections
University of Nottingham
CBS Building
University Park
Nottingham
NG7 2RD
UK
E-mail: richard.james@nottingham.ac.uk

Chapter 14

F. Wiesemann* and R. Adam
Procter & Gamble Service GmbH
Sulzbacher Strasse 40
65824 Schwalbach am Taunus
Germany
E-mail: wiesemann.f@pg.com; adam.r@pg.com

Chapter 15

S. Liu
Department of Textile Sciences
University of Manitoba
Winnipeg
Manitoba R3T 2N2
Canada
E-mail: lius0@cc.umanitoba.ca

G. Sun*
Division of Textiles and Clothing
University of California, Davis
CA 95616
USA
E-mail: gysun@ucdavis.edu

Chapter 16

J. Beringer* and J. Kurz
Hohenstein Institute
Schloss Hohenstein
74357 Bönnigheim
Germany
E-mail: j.beringer@hohenstein.de; j.kurz@hohenstein.de

Chapter 17

R. H. McQueen
Department of Human Ecology
University of Alberta
Edmonton, AB
T6G 2N1
Canada
E-mail: rachel.mcqueen@ualberta.ca

Chapter 18

W. Zhong
Department of Textile Sciences
Faculty of Human Ecology
University of Manitoba
R3T 2N2
Canada
E-mail: zhong@cc.umanitoba.ca

Chapter 19

U. Möhring, D. Schwabe* and S. Hanus
TITV Greiz - Textilforschungsinstitut Thüringen-Vogtland e. V
Zeulenrodaerstrasse 42–44
07973 Greiz
Germany
E-mail: d.schwabe@titv-greiz.de

Chapter 20

W. Nocker
Consultant
Roseggerstrasse 9
85521 Ottobrunn
Germany
E-mail: wnocker@yahoo.de

Chapter 21

M. Walz
Eschler Textil GmbH
Max-Planck-Str. 10
72336 Balingen
Germany
E-mail: michael.walz@eschler.de

Chapter 22

C. Rotsch, H. Oschatz*, D. Schwabe, M. Weiser and U. Möhring
TITV Greiz - Textilforschungsinstitut Thüringen-Vogtland e. V
Zeulenrodaerstrasse 42–44
07973 Greiz
Germany
E-mail: h.oschatz@titv-greiz.de

Chapter 23

G. Bartkowiak* and I. Frydrych
Central Institute for Labour Protection
National Research Institute
Department of Personal Protective Equipment
Wierzbowa 48
90-133 Łódź
Poland
E-mail: grbar@ciop.lodz.pl

I. Frydrych
Technical University of Lodz
90-924 Łódź
Żwirki 36
Poland
E-mail: iwona.frydrych@p.lodz.pl

Chapter 24

L. Van der Schueren* and K. De Clerck
Department of Textiles
Ghent University
Technologiepark 907
9052 Zwijnaarde (Ghent)
Belgium
E-mail: lien.vanderschueren@ugent.be; karen.declerck@ugent.be

Woodhead Publishing Series in Textiles

1 **Watson's textile design and colour Seventh edition**
Edited by Z. Grosicki
2 **Watson's advanced textile design**
Edited by Z. Grosicki
3 **Weaving Second edition**
P. R. Lord and M. H. Mohamed
4 **Handbook of textile fibres Vol 1: Natural fibres**
J. Gordon Cook
5 **Handbook of textile fibres Vol 2: Man-made fibres**
J. Gordon Cook
6 **Recycling textile and plastic waste**
Edited by A. R. Horrocks
7 **New fibers Second edition**
T. Hongu and G. O. Phillips
8 **Atlas of fibre fracture and damage to textiles Second edition**
J. W. S. Hearle, B. Lomas and W. D. Cooke
9 **Ecotextile '98**
Edited by A. R. Horrocks
10 **Physical testing of textiles**
B. P. Saville
11 **Geometric symmetry in patterns and tilings**
C. E. Horne
12 **Handbook of technical textiles**
Edited by A. R. Horrocks and S. C. Anand
13 **Textiles in automotive engineering**
W. Fung and J. M. Hardcastle
14 **Handbook of textile design**
J. Wilson
15 **High-performance fibres**
Edited by J. W. S. Hearle
16 **Knitting technology Third edition**
D. J. Spencer
17 **Medical textiles**
Edited by S. C. Anand
18 **Regenerated cellulose fibres**
Edited by C. Woodings
19 **Silk, mohair, cashmere and other luxury fibres**
Edited by R. R. Franck

20 Smart fibres, fabrics and clothing
Edited by X. M. Tao
21 Yarn texturing technology
J. W. S. Hearle, L. Hollick and D. K. Wilson
22 Encyclopedia of textile finishing
H-K. Rouette
23 Coated and laminated textiles
W. Fung
24 Fancy yarns
R. H. Gong and R. M. Wright
25 Wool: Science and technology
Edited by W. S. Simpson and G. Crawshaw
26 Dictionary of textile finishing
H-K. Rouette
27 Environmental impact of textiles
K. Slater
28 Handbook of yarn production
P. R. Lord
29 Textile processing with enzymes
Edited by A. Cavaco-Paulo and G. Gübitz
30 The China and Hong Kong denim industry
Y. Li, L. Yao and K. W. Yeung
31 The World Trade Organization and international denim trading
Y. Li, Y. Shen, L. Yao and E. Newton
32 Chemical finishing of textiles
W. D. Schindler and P. J. Hauser
33 Clothing appearance and fit
J. Fan, W. Yu and L. Hunter
34 Handbook of fibre rope technology
H. A. McKenna, J. W. S. Hearle and N. O'Hear
35 Structure and mechanics of woven fabrics
J. Hu
36 Synthetic fibres: nylon, polyester, acrylic, polyolefin
Edited by J. E. McIntyre
37 Woollen and worsted woven fabric design
E. G. Gilligan
38 Analytical electrochemistry in textiles
P. Westbroek, G. Priniotakis and P. Kiekens
39 Bast and other plant fibres
R. R. Franck
40 Chemical testing of textiles
Edited by Q. Fan
41 Design and manufacture of textile composites
Edited by A. C. Long
42 Effect of mechanical and physical properties on fabric hand
Edited by Hassan M. Behery
43 New millennium fibers
T. Hongu, M. Takigami and G. O. Phillips

44 Textiles for protection
Edited by R. A. Scott
45 Textiles in sport
Edited by R. Shishoo
46 Wearable electronics and photonics
Edited by X. M. Tao
47 Biodegradable and sustainable fibres
Edited by R. S. Blackburn
48 Medical textiles and biomaterials for healthcare
Edited by S. C. Anand, M. Miraftab, S. Rajendran and J. F. Kennedy
49 Total colour management in textiles
Edited by J. Xin
50 Recycling in textiles
Edited by Y. Wang
51 Clothing biosensory engineering
Y. Li and A. S. W. Wong
52 Biomechanical engineering of textiles and clothing
Edited by Y. Li and D. X-Q. Dai
53 Digital printing of textiles
Edited by H. Ujiie
54 Intelligent textiles and clothing
Edited by H. R. Mattila
55 Innovation and technology of women's intimate apparel
W. Yu, J. Fan, S. C. Harlock and S. P. Ng
56 Thermal and moisture transport in fibrous materials
Edited by N. Pan and P. Gibson
57 Geosynthetics in civil engineering
Edited by R. W. Sarsby
58 Handbook of nonwovens
Edited by S. Russell
59 Cotton: Science and technology
Edited by S. Gordon and Y-L. Hsieh
60 Ecotextiles
Edited by M. Miraftab and A. R. Horrocks
61 Composite forming technologies
Edited by A. C. Long
62 Plasma technology for textiles
Edited by R. Shishoo
63 Smart textiles for medicine and healthcare
Edited by L. Van Langenhove
64 Sizing in clothing
Edited by S. Ashdown
65 Shape memory polymers and textiles
J. Hu
66 Environmental aspects of textile dyeing
Edited by R. Christie
67 Nanofibers and nanotechnology in textiles
Edited by P. Brown and K. Stevens

68 Physical properties of textile fibres Fourth edition
W. E. Morton and J. W. S. Hearle
69 Advances in apparel production
Edited by C. Fairhurst
70 Advances in fire retardant materials
Edited by A. R. Horrocks and D. Price
71 Polyesters and polyamides
Edited by B. L. Deopura, R. Alagirusamy, M. Joshi and B. S. Gupta
72 Advances in wool technology
Edited by N. A. G. Johnson and I. Russell
73 Military textiles
Edited by E. Wilusz
74 3D fibrous assemblies: Properties, applications and modelling of three-dimensional textile structures
J. Hu
75 Medical and healthcare textiles
Edited by S. C. Anand, J. F. Kennedy, M. Miraftab and S. Rajendran
76 Fabric testing
Edited by J. Hu
77 Biologically inspired textiles
Edited by A. Abbott and M. Ellison
78 Friction in textile materials
Edited by B. S. Gupta
79 Textile advances in the automotive industry
Edited by R. Shishoo
80 Structure and mechanics of textile fibre assemblies
Edited by P. Schwartz
81 Engineering textiles: Integrating the design and manufacture of textile products
Edited by Y. E. El-Mogahzy
82 Polyolefin fibres: Industrial and medical applications
Edited by S. C. O. Ugbolue
83 Smart clothes and wearable technology
Edited by J. McCann and D. Bryson
84 Identification of textile fibres
Edited by M. Houck
85 Advanced textiles for wound care
Edited by S. Rajendran
86 Fatigue failure of textile fibres
Edited by M. Miraftab
87 Advances in carpet technology
Edited by K. Goswami
88 Handbook of textile fibre structure Volume 1 and Volume 2
Edited by S. J. Eichhorn, J. W. S. Hearle, M. Jaffe and T. Kikutani
89 Advances in knitting technology
Edited by K-F. Au
90 Smart textile coatings and laminates
Edited by W. C. Smith
91 Handbook of tensile properties of textile and technical fibres
Edited by A. R. Bunsell

92 Interior textiles: Design and developments
Edited by T. Rowe
93 Textiles for cold weather apparel
Edited by J. T. Williams
94 Modelling and predicting textile behaviour
Edited by X. Chen
95 Textiles, polymers and composites for buildings
Edited by G. Pohl
96 Engineering apparel fabrics and garments
J. Fan and L. Hunter
97 Surface modification of textiles
Edited by Q. Wei
98 Sustainable textiles
Edited by R. S. Blackburn
99 Advances in yarn spinning technology
Edited by C. A. Lawrence
100 Handbook of medical textiles
Edited by V. T. Bartels
101 Technical textile yarns
Edited by R. Alagirusamy and A. Das
102 Applications of nonwovens in technical textiles
Edited by R. A. Chapman
103 Colour measurement: Principles, advances and industrial applications
Edited by M. L. Gulrajani
104 Textiles for civil engineering
Edited by R. Fangueiro
105 New product development in textiles: Innovation and production
Edited by L. Horne
106 Improving comfort in clothing
Edited by G. Song
107 Advances in textile biotechnology
Edited by V. A. Nierstrasz and A. Cavaco-Paulo
108 Textiles for hygiene and infection control
Edited by B. McCarthy
109 Nanofunctional textiles
Edited by Y. Li
110 Joining textiles: principles and applications
Edited by I. Jones and G. Stylios
111 Soft computing in textile engineering
Edited by A. Majumdar
112 Textile design
Edited by A. Briggs-Goode and K. Townsend
113 Biotextiles as medical implants
Edited by M. King and B. Gupta
114 Textile thermal bioengineering
Edited by Y. Li
115 Woven textile structure
B. K. Behera and P. K. Hari

116 Handbook of textile and industrial dyeing. Volume 1: principles processes and types of dyes
Edited by M. Clark

117 Handbook of textile and industrial dyeing. Volume 2: Applications of dyes
Edited by M. Clark

118 Handbook of natural fibres. Volume 1: Types, properties and factors affecting breeding and cultivation
Edited by R. Kozlowski

119 Handbook of natural fibres. Volume 2: Processing and applications
Edited by R. Kozlowski

120 Functional textiles for improved performance, protection and health
Edited by N. Pan and G. Sun

121 Computer technology for textiles and apparel
Edited by Jinlian Hu

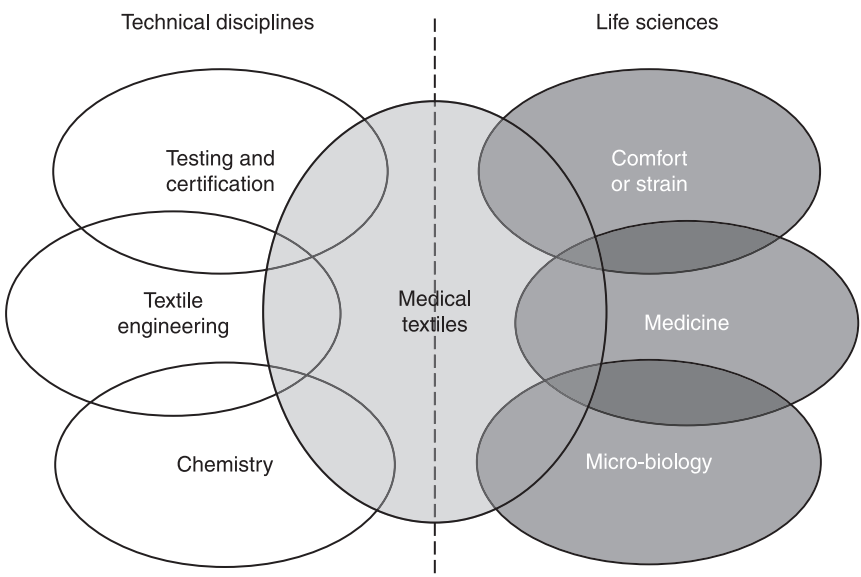
122 Advances in military textiles and personal equipment
Edited by E. Sparks

123 Specialist yarn, woven and fabric structure: Developments and applications
Edited by R. H. Gong

124 Handbook of sustainable textile production
M. Tobler

Preface

Some of the most thrilling applications of textiles are in their medical uses. Medical textiles are located at the interfaces between technical disciplines and life sciences (see Fig. below): On the one hand, representing the technical aspect, we find textile engineering, chemistry and testing and certification; while on the other, we have life sciences like medicine, microbiology and comfort or strain (and this is by no means a complete list). All the different sciences interact and overlap with one another. New developments in one of these sciences may boost new innovations in others, too: for example, new superabsorbent, gel-forming substances invented in chemistry led to the development of new baby diapers and adult incontinence products used in medicine. Three-dimensional spacer fabrics (textile engineering) or bio-functional clothing (chemistry) were rapidly transferred into new medical products like bandages or clothing for patients with



atopic eczema, respectively. Conversely, different disciplines have their own needs, which do not always coincide. For instance, coated or laminated fabrics used in ORgowns led to a significantly higher protection level against body liquids or germs (medicine, microbiology). But the wearers quickly realised that the coating or membrane has to be breathable, i.e. water-vapour permeable, otherwise the wear comfort becomes rapidly inadequate. These various connections between all different aspects make medical textiles such a challenging but fascinating field of research.

Medical textiles can be regarded as a part of the wider category of technical textiles. Here we find links with other applications as in the use of similar materials for different purposes; for example, in the operating theatre protective textiles are used which are similar to other kinds of protective clothing such as that used for chemical, bio-hazard or foul-weather protection. Keeping with this example, new developments intended for foul-weather protective clothing, like densely woven microfibre fabrics or breathable laminated textiles, were established as OR gowns, too. As a consequence the surgeon and the other operating room staff achieved a higher level of protection plus a good wear comfort.

Medical textiles are not only a fascinating research area, but are also extremely important from the economic point of view. Medical textiles are decisive elements of the progress made in medicine, which often result in new medical textile products and vice versa. Consequently medical textiles are today an inevitable constituent of modern disease management. A strong additional impetus for the need for medical textiles is generated by the increasing number of elderly people in the populations of developed countries.

Starting from common cotton fabrics, medical textiles have shown rapid development over the last few decades. This progress affects nearly all textile sectors: New, bio-degradable fibre constituents enabled novel types of implants; recent textile machines allow for three-dimensional spacer fabrics; and silver-ion based finishes effectively reduce bacteria growth. In this way the field of medical textiles has grown extensively over the years. As a consequence, it became a difficult area to understand and to review.

This book sets out to embrace several important aspects of medical textile research, development and applications. It can be taken as a starting point for readers to familiarise themselves with medical textiles, and allows experienced readers to expand their knowledge.

The book is divided into four parts: First, the types and properties of medical textiles; second, textiles and the skin; third, textiles for hygiene; and fourth, medical textile case studies and applications. The parts are further divided into several chapters. Each chapter can be regarded as a standalone review article, written by a leading expert in his field. Authors are from universities, research organisations, industry and hospitals, reflecting the diverse nature of medical textiles. Accordingly the chapters will be of great benefit to readers from a wide variety of institutions.