

HANDBOOK OF TECHNICAL TEXTILES

Edited by
A R Horrocks and S C Anand



The Textile Institute



CRC Press
Boca Raton Boston New York Washington, DC

WOODHEAD PUBLISHING LIMITED

Cambridge England

Published by Woodhead Publishing Limited in association with The Textile Institute
Abington Hall, Abington
Cambridge CB1 6AH
England
www.woodhead-publishing.com

Published in North and South America by CRC Press LLC, 2000 Corporate Blvd, NW
Boca Raton FL 33431, USA

First published 2000, Woodhead Publishing Ltd and CRC Press LLC
© 2000, Woodhead Publishing Ltd except Chapter 16 © MOD
The authors have asserted their moral rights.

This book contains information obtained from authentic and highly regarded sources. Reprinted material is quoted with permission, and sources are indicated. Reasonable efforts have been made to publish reliable data and information, but the authors and the publishers cannot assume responsibility for the validity of all materials. Neither the authors nor the publishers, nor anyone else associated with this publication, shall be liable for any loss, damage or liability directly or indirectly caused or alleged to be caused by this book.

Neither this book nor any part may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying, microfilming and recording, or by any information storage or retrieval system, without permission in writing from the publishers.

The consent of Woodhead Publishing and CRC Press does not extend to copying for general distribution, for promotion, for creating new works, or for resale. Specific permission must be obtained in writing from Woodhead Publishing or CRC Press for such copying.

Trademark notice: Product or corporate names may be trademarks or registered trademarks, and are used only for identification and explanation, without intent to infringe.

British Library Cataloguing in Publication Data

A catalogue record for this book is available from the British Library.

Library of Congress Cataloguing in Publication Data

A catalog record for this book is available from the Library of Congress.

Woodhead Publishing ISBN 1 85573 385 4

CRC Press ISBN 0-8493-1047-4

CRC Press order number: WP1047

Cover design by The ColourStudio

Typeset by Best-set Typesetter Ltd, Hong Kong

Printed by St Edmundsbury Press, Suffolk, England

To the past and present staff members, support staff and students in Textile Studies at Bolton Institute, for their friendship and support over the years.

Preface

Technical textiles are reported to be the fastest growing sector of the textile industrial sector and account for almost 19% (10 million tonnes) of the total world fibre consumption for all textile uses, totalling 53 tonnes in 1997. This figure is likely to increase to 14 million tonnes by the year 2005. Technical textiles are estimated to account for well over 40% of the total textile production in many developed countries and, at the year 2000, account for almost 20% of all textile manufacturing in China (Byrne 1997).

The current volume of the market worldwide for technical textiles is more than \$60 billion. The average annual growth rate of technical textiles worldwide is expected to be around 3.8% for the period 2000 to 2005.

The uniqueness and challenge of technical textiles lies in the need to understand and apply the principles of textile science and technology to provide solutions, in the main to technological problems but also often to engineering problems as well. With the emphasis on measurable textile performance in a particular field of application, this requires the technologist to have not only an intricate knowledge of fibres and textile science and technology but also an understanding of the application and the scientists, technologists and engineers who service it. Thus the producer of geotextiles requires an intricate knowledge of the world of civil engineering, and the medical textile producer, the requirements of consultant, medical practitioner and nurse. This series attempts to provide a bridge between producer and end-user.

The main principles involved in the selection of raw materials and their conversion into yarns and fabrics followed by dyeing, finishing and coating of technical textiles are explored, followed by the raw materials, processing techniques, finishing, specifications, properties and special technical and commercial features of a wide range of specific areas of application.

Each of the chapters has been specially prepared and edited to cover current developments as well as future trends in both the principles of manufacture and the state-of-the-art constructional specifications, properties, test methods and standards of the major product areas and applications of technical textiles.

A team of internationally famous authors has contributed a great deal of time, effort and above all special and significant expertise and experience to the preparation of this handbook. The editors wish to extend their most sincere thanks to all the authors for their important contribution, patience and cooperation. This book once again confirms that enthusiasm and love of the subject are more important than the financial gains.

Special thanks are also given to Patricia Morrison of Woodhead Publishing Ltd, Cambridge for her consistent interest and effort in keeping this project warm for so long and her continued faith in the editors.

Professor Richard Horrocks
Professor Subhash Anand
Faculty of Technology
Bolton Institute
Deane Road
BOLTON
BL3 5AB
UK

List of contributors

Professor S C Anand

Faculty of Technology, Bolton Institute, Deane Road, Bolton BL3 5AB, UK

Professor P Bajaj

Department of Textile Technology, Indian Institute of Technology, Hauz Khas, New Delhi, India

Mr C Byrne

David Rigby Associates, Peter House, St Peter's Square, Manchester M1 5AQ, UK

Dr X Chen

Department of Textiles, UMIST, P O Box 88, Sackville Street, Manchester M60 1QD, UK

Mr W Fung

Collins and Aikman, P O Box 29, Warley Mills, Walkden, Manchester M28 3WG, UK

Dr R H Gong

Department of Textiles, UMIST, P O Box 88, Sackville Street, Manchester M60 1QD, UK

Dr M Hall

Department of Textiles, Faculty of Technology, Bolton Institute, Deane Road, Bolton BL3 5AB, UK

Mr E Hardman

Madison Filters (formerly Scapa Filtration), Haslingden, Rossendale, Lancashire, UK

Dr I Holme

Department of Textiles, University of Leeds, Leeds LS2 1JT, UK

Dr D Holmes

Department of Textiles, Faculty of Technology, Bolton Institute, Deane Road, Bolton BL3 5AB, UK

Dr M MirafTAB

Department of Textiles, Faculty of Technology, Bolton Institute, Deane Road, Bolton BL3 5AB, UK

Dr S Ogin

School of Mechanical and Materials Engineering, University of Surrey, Guildford, Surrey GU2 7HX, UK

Dr M Pritchard

Department of the Built Environment, Faculty of Technology, Bolton Institute, Deane Road, Bolton BL3 5AB, UK

Professor P R Rankilor

9 Blairgowrie Drive, West Tytherington, Macclesfield, Cheshire SK10 2UJ, UK

Mr A J Rigby

Department of Textiles, Faculty of Technology, Bolton Institute, Deane Road, Bolton BL3 5AB, UK

Professor S W Sarsby

Department of the Built Environment, Faculty of Technology, Bolton Institute, Deane Road, Bolton BL3 5AB, UK

Dr R A Scott

MOD, Defence Clothing and Textiles Agency Science and Technology Division, Flagstaff Road, Colchester, Essex CO2 7SS, UK

Professor K Slater

Department of Textiles, University of Guelph, Guelph, Ontario N1G 2W1, Canada

Dr P Smith

26 Newhall Park, Otley, Leeds LS21 2RD, UK

Mr W Sondhelm

10 Bowlacre Road, Hyde, Cheshire SK14 5ES, UK

HANDBOOK OF TECHNICAL TEXTILES

Edited by
A R Horrocks and S C Anand



The Textile Institute



CRC Press
Boca Raton Boston New York Washington, DC

WOODHEAD PUBLISHING LIMITED

Cambridge England

Published by Woodhead Publishing Limited in association with The Textile Institute
Abington Hall, Abington
Cambridge CB1 6AH
England
www.woodhead-publishing.com

Published in North and South America by CRC Press LLC, 2000 Corporate Blvd, NW
Boca Raton FL 33431, USA

First published 2000, Woodhead Publishing Ltd and CRC Press LLC
© 2000, Woodhead Publishing Ltd except Chapter 16 © MOD
The authors have asserted their moral rights.

This book contains information obtained from authentic and highly regarded sources. Reprinted material is quoted with permission, and sources are indicated. Reasonable efforts have been made to publish reliable data and information, but the authors and the publishers cannot assume responsibility for the validity of all materials. Neither the authors nor the publishers, nor anyone else associated with this publication, shall be liable for any loss, damage or liability directly or indirectly caused or alleged to be caused by this book.

Neither this book nor any part may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying, microfilming and recording, or by any information storage or retrieval system, without permission in writing from the publishers.

The consent of Woodhead Publishing and CRC Press does not extend to copying for general distribution, for promotion, for creating new works, or for resale. Specific permission must be obtained in writing from Woodhead Publishing or CRC Press for such copying.

Trademark notice: Product or corporate names may be trademarks or registered trademarks, and are used only for identification and explanation, without intent to infringe.

British Library Cataloguing in Publication Data

A catalogue record for this book is available from the British Library.

Library of Congress Cataloguing in Publication Data

A catalog record for this book is available from the Library of Congress.

Woodhead Publishing ISBN 1 85573 385 4

CRC Press ISBN 0-8493-1047-4

CRC Press order number: WP1047

Cover design by The ColourStudio

Typeset by Best-set Typesetter Ltd, Hong Kong

Printed by St Edmundsbury Press, Suffolk, England

To the past and present staff members, support staff and students in Textile Studies at Bolton Institute, for their friendship and support over the years.