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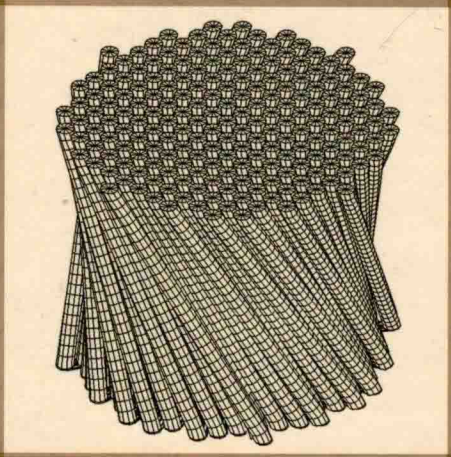

Modelling and predicting textile behaviour

Edited by X. Chen

CRC

The Textile Institute

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Contributor contact details

(*= main contact)

Chapter 1

Dr Xiaogang Chen* and Professor John Hearle
School of Materials
The University of Manchester
Manchester
M60 1QD
UK

Email: xiaogang.chen@manchester.ac.uk

Chapter 2

Dr Sergei Grishanov
TEAM Research Group
De Montfort University
The Gateway
Leicester
LE1 9BH
UK

Email: gsa@dmu.ac.uk

Chapter 3

Dr Rade Ognjanovic
Innoval Technology Limited
Beaumont Close
Banbury
OX16 1TQ
UK

Email: rade.ognjanovic@innovaltec.com

Chapter 4

Dr Emmanuelle Vidal-Salle and Professor Philippe Boisse*
INSA Lyon
20, rue Albert Einstein
69621 Villeurbanne Cedex
France

Email: philippe.boisse@insa-lyon.fr
emmanuelle.vidal-salle@insa-lyon.fr

Chapter 5

Dr Ningtao Mao,* S. J Russell
Centre for Technical Textiles
University of Leeds
Leeds
LS2 9JT
UK

Email: n.mao@leeds.ac.uk

Chapter 6

Professor Dr Yordan Kyosev*
Department of Textile and Clothing Technology
Niederrhein University of Applied Sciences
D-41065 Mönchengladbach
Germany

Email: yordan.kyosev@hs-niederrhein.de

Dipl.-Ing. Wilfried Renkens
Renkens Consulting
Tittardsfeld 102
D-52072
Germany

Email: W.Renkens@gmx.de

Chapter 7

Dr Mohammad Ali Nazarboland,* Dr Xiaogang Chen and Professor John W. S. Hearle
School of Materials
The University of Manchester
Manchester
M60 1QD
UK

Email: Nazarboland@gmail.com
xiaogang.chen@manchester.ac.uk

Professor Richard Lydon and Martin Moss
Clear Edge Group
Knowsley Rd Industrial Estate
Haslingden
BB4 4EJ
UK

Chapter 8

Professor Renzo Shamey
North Carolina State University
Raleigh
NC 27695-8301
USA

Email: rshamey@ncsu.edu

Chapter 9

David P. Oulton
School of Materials
Sackville St Building
The University of Manchester
Manchester
M60 1QD
UK

Email: david.oulton@manchester.ac.uk

Chapter 10

Dr Fan Han*
Middlesex University
London
NW4 4BT
UK

Email: fanhankw@yahoo.co.uk

Professor George K. Stylios
Heriot-Watt University
Edinburgh
EH14 4AS
Scotland

Email: G.Stylios@hw.ac.uk

Chapter 11

Professor Michael Hann* and Dr Briony G. Thomas
School of Design
University of Leeds
Leeds
LS2 9JT
UK

Email: m.a.hann@leeds.ac.uk
B.G.Thomas@leeds.ac.uk

Chapter 12

Dr Xiaogang Chen
School of Materials
The University of Manchester
PO Box 88
Manchester
M60 1QD
UK

Email: xiaogang.chen@manchester.ac.uk

Chapter 13

Professor Renzo Shamey,* Dr W Shim and Professor J.A. Joines
North Carolina State University
Raleigh
NC 27695-8301
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Preface

'Textiles' refer to fibres and fibre assemblies that are used principally as raw materials for different types of products. Under this definition, textiles will include fibres (be they natural or manufactured, short staples or continuous filaments), yarns (be they single strand or cabled) and fabrics (be they woven, knitted, braided or non-woven, two dimensional or three dimensional). For garments, beddings, curtains, floor coverings, as well as technical end-use (such as a type of textile composites), textile fabrics are the raw materials, providing not only the appearance, texture and decorative features but also the various properties that make the textile suitable for the intended applications. Textiles are popular types of material that have been widely used domestically and industrially.

However, textiles as types of material are special when compared to materials such as metal. Textiles are far from homogenous and isotropic because they are assemblies of fibres. On the other hand they are soft materials compared to their metallic counterparts. Furthermore, fibres are made of wide range of different chemical compositions and when different fibres are used for making textiles, the physical and chemical properties can be vastly different. Because of all these special features, prediction of textile behaviour has been drawing much attention and effort over the years. This book is presented with the aim of introducing the methods and techniques that have been developed in modelling and predicting fabric properties and behaviour for most current end-use applications.

The textile hierarchy begins with fibre as the basic element. Fibres are the construction units of yarns and some non-woven fabrics. Then yarns are used as components for making fabrics based on weaving, knitting and braiding technologies. It is essential to understand fibre behaviour which is largely determined by the chemical structure of the polymer and physical configuration of the molecular chain. Based on the fibres, it could be claimed that the behaviour of a textile assembly is a function of the properties of the building block and the way that these building blocks are constructed in the assembly. Following this logic, the behaviour of yarn depends on the fibre property and the yarn construction and the fabric behaviour is determined by

the properties of the composing yarn and construction of the fabric. A fabric contains a tremendous amount of fibres of the same or different types and there are endless ways that a fibre is configured individually or collectively in a fabric. Phenomena such as these make the modelling of textiles very challenging.

Textiles are used in many different ways for different functions. Mechanical behaviour certainly is one of the most important aspects, because strength and durability are the most essential requirements of a textile product. Part I of this book addresses the fundamental issues in modelling and predicting textile behaviour. The first chapter gives an overview of the structural hierarchy and outlines the techniques and progress made in modelling fibres, yarns and fabrics. Techniques for detailed fibre and yarn modelling are given in two following chapters. Modelling of woven, knitted and nonwoven fabrics are described in three separate chapters, giving detailed insight into the modelling of these three very different types of fabric.

Part II of this book lays emphasis on modelling of textiles for particular applications and case studies of individual problems in individual applications. When textile fabrics are used as the filtering media for air and water purification, the orifice of the fabrics becomes important. Chapter 7 reports on a study where the woven fabrics are used in a filtration application, analysing the influence of the fabric structural parameters on the filtration performance and behaviour. Modelling dyeing of textiles is explained in Chapter 8, where numerous models for predicting textile dyeing process are introduced. After Chapter 9 on the modelling of colour properties for textiles where basic models and some case studies are given, Chapter 10 discusses the modelling and simulation of the drape of textiles and garments. In this chapter, the authors explain the key principle of the three-dimensional (3D) mass–spring models that facilitate dynamic drape. Parallel to the modelling of the technical aspects of textiles, Chapter 11 discusses the modelling of patterns that are used for fabric printing. Three-dimensional textiles become more and more of interest to industry for their structural integrity and special properties. Chapter 12 is included to explain the structural and mechanical modelling of 3D cellular textile composites for impact energy absorption and for force attenuation. The progress made in modelling leads to engineering and manufacture of better textiles. The book ends with Chapter 13 on the development and application of expert systems in the textile industry.

I would like to take this opportunity to thank all contributors for their valuable time devoted to writing the chapters for this exciting book. I also wish to extend my gratitude to my beloved family for their support and for permitting me the time taken away from them for all those weekends and late evenings.

Xiaogang Chen

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