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Book Review

Functional Finishes for Textiles—Improving Comfort, Performance and Protection, edited by Roshan Paul (Woodhead Publishing in association with Textile Institute, Manchester, England), 2015, pp. 678, Price $210.00.

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There is a great demand for textiles with specific functional properties. The modification of conventional fibres and fabrics with innovative finishes is a cheaper route to high performance than by using expensive inherently high performance fibres. In this context, the book on Functional Finishes, edited by Dr. Roshan Paul who is currently working at the Function and Care Department, Hohenstein Institute, Germany, is very valuable contribution. The editor must be congratulated for successfully compiling contributions from experts in the field from internationally known textile institutes, research organizations and textile industries from Portugal, Spain, Germany, Australia, Netherlands, China, Ireland, USA, Switzerland, Turkey, Greece, Italy, and Belgium. It is heartening that there are contributions from two textile institutes from India namely Indian Institute of Technology, Delhi and Institute of Chemical Technology, Mumbai. The book is divided into two parts with 20 chapters.

Part I describes the finishes to improve comfort and performance. Topics include thermal regulation, moisture management, shrink resistance, easy care, self cleansing, super absorbance, and finishes for medical and cosmetic textiles. Part II focuses on finishes for the protection of wearer and textiles to make them insect repellent, antimicrobial, flame retardant, radiation protective, biological and chemical protective, ballistic and impact protective. The final chapter provides an in-depth look at the environmental and safety issues concerning the functional finishes. Each chapter covers background information, mechanism, chemistry, methods of application, testing and future trends along with exhaustive references. The salient features of the contents are briefly highlighted hereunder.

The chapter on thermoregulation provides a comprehensive review of phase change materials (PCM) in the design and manufacture of thermoregulated textiles. In case of moisture management, the type and application method of the selected finishes is such as to enhance the wicking properties and thus facilitate the transport of moisture from the skin of the wearer to the outer surface of the fabric, where it can evaporate. On the other hand, the performance of soil release finish depends upon its ability to provide a hydrophilic surface during laundering. Next generation smart textiles could see the development of fabrics which are able to respond to changes in the environment by adjusting their pore size or thickness to allow moisture through.

Final hand of the fabric plays a crucial role in influencing the decision of consumer, therefore softening finishes are always going to remain among the most important finishes for textiles and apparels. The research in this area will continue to gather impetus in the quest to improve selection of the blends of softeners and their performance and durability, to overcome the problem of thermomigration and adverse effects on crock fastness and to reduce environmental impact. Enzymes are environment-friendly tools for the biofinishing of synthetic polymers, with pronounced effect on their surface. The purpose of enzymatic surface modification of PET, PA and PAN is to increase hydrophilicity locally. The bulk properties of these fibres are not affected because the enzymes used are too big to penetrate into the bulk phase of the fibre. With traditional enzymes and the organisms, contamination is a major problem. New high temperature enzymes and thermophilic organisms can overcome the problem of contamination by allowing the process to be run at high temperature where common contamination organisms cannot survive.

In shrink-resist finishing of wool, emphasis has been given to review those processes that have stood the test of time on commercial scale. The easy care and durable press finishing is an essential requirement for cellulose and cellulose blends. The major R & D

efforts have been made in the development of formaldehyde free finishing agents. The use of polycarboxylic acids is an important method, though still there are limitations in complete replacement of formaldehyde. Ongoing research activities will eventually lead to formaldehyde free alternatives. Theoretical understanding of the relationship among surface morphology, surface chemistry and wettability of textile surfaces is essential for the development of self cleansing finishes. However, most of the experimental techniques involve tedious and multi-step procedures which put limitations on commercial production. The field of self cleansing textiles is at nascent stage and continues to provide opportunities for further research and development.

Superabsorbent textiles are currently encountered in all basic aspects of daily life, such as, health, food, works and leisure. It is therefore essential that consumer safety is given top priority in their manufacturing. Binding of Cyclodextrins and microcapsules with active substances to textile surface have proved to be important techniques in the development of medical and cosmetic finishes. The active substances may be antioxidants, fragrances, skin softeners, insect repellent, vitamins, UV blockers, etc. Cyclodextrins and microcapsules act as reservoirs and enable a progressive release when the textile rubs in contact with skin. Mosquito repellent textiles provide the much needed feature of driving away mosquitoes, thereby providing safety from mosquito borne diseases such as malaria, dengue fever, yellow fever, chikungunya, etc. which are serious in tropical regions.

Some promising techniques for improving the durability of insect finishes include electrospinning, microencapsulation, sol-gel doping, entrapment in cyclodextrin, etc. The rise in consumer awareness on hygiene and well being has created a high demand for antimicrobial textiles. To cater to these demands several research efforts have been made in developing antimicrobial finishes for natural and synthetic textiles. The future market for antimicrobial finishes is very promising. Some textile industries have responded to this demand by launching new antimicrobial products using wide range of biocides such as silver nanoparticles, polyhexamethylene biguanide and quaternary ammonium compounds as the active agents. Some antimicrobial agents can be incorporated into synthetic fibres during the extrusion stage.

The chapter on hydrophobic and hydrophililic finishes summarizes methods for producing commercially successful products and worldwide research efforts for the processes under development. Recent developments on flame retardants have mostly focused on new chemistry which is primarily active in the condensed phase of P-N based synergism. New environmental, health and fire regulations are forcing some halogenated flame retardants to be phased out. Novel application techniques such as plasma, layer-by-layer and sol-gel have been developed recently but the durability to washing of such treatments is questionable. Future developments of flame retardants will focus more on new chemistry based on phosphorus, nitrogen and silicone.

The current state of UV protective finishing focuses mainly on inorganic nanoparticle coating onto fabrics. Although such coatings are efficient in providing UV protection to the user, their photocatalytic activity can catalyse the fibre degradation. Thus, the future challenges lie in how to reduce photocatalytic capability from the inorganic nano UV blockers, and improvement of wash fastness. There are also potentially challenging issues of the health and safety risks of nanoparticles.

The chapter on radiation protection finishes provides an overview of current finishing techniques. New finishing chemicals, new application methods and new products continue to appear in this field. Antistatic agents are the finishes that can be applied to fibre or fabric for the dissipation of static charge build-up. While there is range of commercial antistatic finishing agents, truly durable chemical agents are not available. Fabrics with yarns containing electrically conducting materials at intervals provide good static charge dissipation with durability to washing. There are still difficulties in clear understanding of the mechanism of static charge generation on, and decay from, polymer surfaces. Therefore, the development of significant theoretical understanding supported by experimental verification to develop practical rules might provide guidance to those working in this area.

In modern era of warfare, the defense industry faces a challenging task to tackle chemical, biological, radiological and nuclear (CBRN) threats. Therefore CBRN protective clothing should offer multiple functionalities to the war fighters. An integrated protective suit concept is being proposed by the US military. In order to develop multidimensional

protective systems, multidisciplinary research efforts are essential. The Global market for ballistic protective clothing (bullet, knife stab, needle and spike stab resistance) is increasing with annual growth rate of 5%. New research efforts are focused on the use of shear thickening fluids (STF). These are non-Newtonian fluids based on dense colloidal dispersions of solid particles of different materials in a liquid carrier. On impact these fluids change viscosity from a liquid range to a solid like range. A high quantity of impact energy can be absorbed by STFs, equivalent to that absorbed by the lightweight high performance multilayered textiles. Shear thickening behavior is reversible, making the body armor flexible enough for normal mobility of the soldier. Very interesting alternatives to STF are ceramic or metallic coatings applied onto textiles by thermal spray, and silicone based dilatant powders applied by powder spray guns. However, these technologies are still in their infancy.

The last chapter of the book presents an overview of the environmental and safety issues related to functional finishing. Ecolabelling systems are good tools for this purpose. Research related to functional finishing is being influenced by the need not only to develop innovative and improved functionalities but also to fulfill the demands in terms of health, safety and environmental protection.

The inclusion of a chapter on Care and Maintenance of Functionally Finished Textiles could have made the book more complete. The book will be an excellent resource for both R & D managers in the textile industry and academic researchers in the area of technical textiles. The overall layout of the book meets the international standards; however a slightly larger font size would have been appreciated by senior readers.

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