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# Advancements in Textile Finishing

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***Abstract:*** *A lot of interesting advancements have been witnessed within the last two decades in the clothing and textile industry. In this review, different methods of textile finishing are hereby explained. Whereas the conventional methods of finishing including wet and dry finishing techniques are still being practiced on cotton and woolen fabrics, advanced textile finishing techniques may include functionalization using nano-coatings, surface modification using hydrolyzable silanes, enzymes, microencapsulation, and the strengthening of synthetic fibres with nano-coatings and nano-clays, to mention but a few. These techniques induce different textures and performance characteristics onto the textile materials, making them textile materials for the future, otherwise "futuristic" textiles from apparels and garments to technical textiles that respond effectively to changes within the environment and human body. This would make it possible for futuristic textiles to be widely applied in a variety of situations and environments.*

***Keywords:*** *Coloration, Dyeing, Enzymes, Finishing, Microencapsulation, Nanotechnology, Aerodynamic*

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## I. Introduction

Textile Finishing refers to a whole lot of processes, procedures and methods for impacting on the quality of the fibre before and / or after fabric production. Finishing encompasses chemical and mechanical treatments performed on fibres, yarn, or fabric in other to improve appearance, texture, or performance. Some of the chemical methods in yarn / fabric finishing include acid or alkali treatment, bleaching, dyeing and printing, while some of the mechanical methods in yarn / fabric finishing include brushing, shearing, pressing, raising, beating, calendaring, and folding. Finishing is done in three stages which are pre-treatment, colouration and finishing.This definition may be seen as only pertaining to age-long traditional cotton fabric whereby grey fabrics are made to undergo series of pre-treatments involving de-sizing, scouring and mercerization using sodium hydroxide, bleaching with hypochlorite or peroxides, dyeing and then screen / rotary printing of different designs. Lastly, drying and calendaring the textile fabrics are the final post-treatment processes. During the pre-treatment stage, use of water, chemicals, dyestuffs and pigments with attendant release of wastewater effluents, is prevalent. In some of the textile factories, collection of the effluents resulting from these operations is done with carefully planned layout of pipes channelled to an effluent treatment plant where the wastewater is treated, refined and re-used for the steam boilers and pre-treatment operations(Nkeonye, 1993, 2009).

However, as a result of the constantly evolving consumer lifestyles, demand for comfort and increased applications of textile materials in technical areas within the last two decades, the global textile industry has adopted a forward-looking approach in order to create new conceptual textile systems for the 21st century. This has resulted in the production of functional textile materials from fibre to fabrics, using both natural and synthetic fibres / polymers. In most cases, functionalization of the textile fabrics is achieved at the finishing stage. It is therefore imperative to review a series of advancements in finishing of textile materials so as to see ways process and procedures can be improved upon, to achieve better performance products / apparels.

## II. Conventional Textile Finishing

The conventional textile finishing can be grouped into dry or mechanical finishing and wet or chemical finishing. However, there are three basic steps involved in conventional textile finishing, which include;

i. Washing and drying
ii. Stabilising the fibre, yarns or fabric
iii. Pressing / ironing / calendaring to add aesthetics to the yarns or fabric

## 2.1 Dry or Mechanical Finishing

Mechanical finishes involve brushing, ironing or other physical treatments used to increase the lustre and feel of textiles. This requires textile materials being worked on by mechanical equipment such as calendars, rollers and pressing irons. Mechanical finishes such as raising and calendaring do not contribute to pollution. In most cases, mechanical finishing is targeted at the fibre or fabric feel and texture, surfaces, looks and appearance(Joshi & Butola, 2013), as well as optical properties. Some of the mechanical treatments include;

### 2.1.1 Heat-Setting

Heat-setting involves subjecting textile materials; fibres, yarn and fabrics, to a certain range of temperatures under tension over a period of time. It is a dry processing technique used to stabilize and impart texture to synthetic fabrics and natural fabrics containing a high percentage of synthetics. When manmade fibres are heat-set, the fabric is made dimensionally stable while maintaining its shape and size during and after subsequent finishing operations. It is evened out in the form in which it is held during heat-setting, smoothened, creased, and uneven. As a result, induced textural properties may include interesting and durable surface effects such as pleating, creasing, puckering, and embossing. Heat-setting also makes fabrics to acquire wrinkle resistance during wear and ease-of-care properties when in use which can all be attributed to improvements in resilience and in the elasticity of the component warp and weft yarns. Pollution outputs may include volatile components of yarn spinning finishes if heat-setting is performed before scouring and bleaching processes. These processes may not be easily applied to natural fibres and fabrics, but the volatile components are introduced to the fabrics during the manufacture of synthetic fibres when proprietary spin finishes are applied to provide lubrication and antistatic characteristics to the synthetic fibres and fabrics.

2.1.2 Brushing and napping

Brushing and napping the fabric with the use of wires or brush to pull individual fibres, reduce the lustre of fabrics by abrading the surface fibre and making some of the individual fibre to hover on the fabric surface thereby inducing a fluffy, soft texture unto the fabric.

2.1.3 Softening

Calendaring or ironing is used to reduce surface friction between individual fibres thereby softening the fabric structure and increasing its sheen. In calendaring, the fabric is made to pass through two or more rolls. One of the rolls is made of steel which may either be connected to a chilling pipe from a cold water supply or a heating pipe from steam from a boiler or gas. Once fabric materials pass through the machine, they are wound up at the back of the machine at the other end.

2.1.4 Optical finishing

Usually when fabrics are flattened or smoothened under pressure during calendaring, the fibres on the surface of they are made to lay flat on the fabric surface thereby increasing light scattering. Lustre is induced to yarns by this technique and may be further improved should the rolls be scribed with closely spaced lines.

2.1.5 Shearing

This process eliminates floating fibres by transiting the fabric over a cutting blade to a take-up roll.

2.1.6 Compacting

Compacting includes a sanforizing process as is in the case of woollen fabric. Here, the woollen materials are put in-between blanket cotton fabrics and compressed in order to reduce stresses in the woollen fabric. Woollen fabrics are prone to a high degree of dimensional shrinkage during washing, and as a result, this process, when carried out, helps to reduce residual shrinkage of the fabrics after several washing processes. Normally, the woollen fabric and backing blanket are fed between a roller and a curved braking shoe, while keeping the blanket in tension until both the woollen fabric and blanket pass the braking shoe. Compacting reduces excessive shrinkage that may arise during and after laundry activities.

## 2.2 Wet or Chemical Finishing

Application of chemical finishes to textiles positively affects fabrics by way of reducing static cling and improving fabric flame retardant property. This involves chemical dissolution in solvent media and subsequent use of the solution in treating textile materials. Solvent media may be water, starch, dyes and pigments in organic liquor, or chemicals dissolved in water. This type of treatment is usually associated with the release of volumes of wastewater as effluents. However, if finishes are to be applied by a pad-dry-bake technique as in the case of resin treatment, waterproofing, flame-proofing and soil release / self-cleaning finishing, only small amounts of waste products are released.The most common chemical finishes are those that ease fabric care, such as the permanent-press, soil-release, and stain-resistant finishes. Chemical finishes are usually followed by drying, curing, and cooling steps which are often done in conjunction with mechanical finishing.

In knitting, lubricating finishes are applied to knitting yarns. They are based on mineral oils, vegetable oils, synthetic ester-type oils or waxes, and may also incorporate antistatic agents, antioxidants, bacteriostats and corrosion inhibitors. The knitting oils are readily emulsified or solubilised in water and are thrown into the waste-water after a series of washing stages before dying and printing on the fabric (Nkeonye, 2009). Some selected chemical finishes are explained below.

2.2.1 Optical finishes

These are applied to the textile material to increase or reduce light scattering on the material, which could either brighten or dull the fabric as the case may be.

2.2.2 Absorbent and soil release finishes

They are done on textile materials in order to alter surface tension and other properties to increase water absorbency or improve soil release. If the surface tension of the textile surface is increased, the material will likely retain droplets of water, but if reduced, the droplets of water will run-off the surfaces of the material unaided carrying with them dirt and dust particles.

2.2.3 Softeners and abrasion-resistant finishes

Softeners and abrasion resistant finishes are added to improve feel or to increase the ability of the textile to resist abrasion and tearing.

2.2.4 Physical stabilization and crease-resistant finishes

These finishes are done to stabilize cellulosic fibres during laundering and shrinkage. Whereas crease-resistant finishes impart anti-crease properties during laundering and drying, while permanent press properties to fabrics are achieved with the application of physical stabilization finishes.

2.2.5 Dyeing and colouration

Dyeing is the process of fixation of dye chemical compounds to a substrate which may be fibre, yarn or fabric. This is done with the intention of creating a uniform colour effect on the substrate. A dye is a colourant chemical compound, natural or synthetic, that is dispersed in its application medium before being absorbed, adsorbed, reacted with, or deposited on, a substrate. They are different from pigments because they are soluble in water and possess substantivity (attractiveness) for their substrate. Dyes are applied to substrates based on their attractiveness to the component fibres (Baumann, 1966). ***Pigments***are neither soluble in water nor exhibit attractiveness property towards fibre substrates. They are mainly inorganic nano-sized powders / filler colourants. Also referred to as ***"disperse dyes",*** they nanoparticles which may be finely dispersed in polymers, synthetic or man-made fibres and are not soluble in water. They are compounded with polymer resins to produce paints, plastics, synthetic and man-made fibres made of cellulose acetates / triacetates, viscose rayon, polyesters, polyamides (nylons), acrylic and polyolefin-based fibres.

***Direct dyes or naphthols*** are those that exhaust on cellulosic fibres from a neutral or weakly alkaline solution because they have an affinity for cotton and other cellulosic fibres when applied from a dye-bath containing salt. They are applied to cellulosic fibres as a result of inherent surface hydroxyl end groups on the fibres. They are based on azo compounds containing sulfonic radical which makes them soluble in water, hence they are also referred to as *"acid dyes".*

***Basic dyes*** are water-soluble sulphuric acid esters of the vat dyes. They are applied to woollen, orlon, and acrilan materials from a water solution and are then converted to the original dyestuff by treatment with an oxidizing agent in acid solution.

***Vat dyes*** are dyes which are applied to cellulosic fabrics and rayon to produce very nice shades by "*vatting",* reducing first with sodium hydrosulphite in an alkaline medium before application.

***Fibre-reactive dyes*** area very new and interesting class of dyes, the fibre-reactive dyes actually combine chemically with the fibre. They are applied in dyeing and printing cotton and viscose rayon. They are faster than direct dyes but not as fast as vat dyes in many respects.

Dyes are ubiquitous compounds. Natural dyes may be extracted from plants or synthesized chemically, and are basically used to produce brightly colored fabrics for clothes, beddings, curtains, and are also applied in areas as diverse as fabric-softened clothes, fire-retardant fabrics, upholstery / furniture covers, and water-shedding umbrellas. Dyes may be screen-printed on a fabric surface, where selected surfaces of the fabric are patterned with eye-catching designs or fabric immersion in a dye-bath where the entire yarn or fabric is covered with dye solution, allowed time for fixation at a particular temperature before drying.

Dyeing and colouration are smart ways to impart value to textiles for attributes such as hue and comfort with the aim of increasing product appeal, allure, desirability and performance.

*2.2.5.1 Factors in Dyeing*

Each of these factors is closely dependent on the others. For instance, if the fibre to be dyed cannot absorb liquor, it will be difficult to obtain complete penetration of the dyes. Also, if the water, which is the medium most commonly used in dyeing, is excessively hard, some of the dyes may be precipitated and separated from the solution, causing specking and uneven dyeing. Therefore, the basic considerations in dying are as follows;

*i.* ***The fibre*** to be dyed may be natural or synthetic. Natural fibres are generally classified into two main groups; animal or protein fibres and vegetable or cellulosic fibres. The animal fibres include wool, mohair, alpaca and silk, to name a few. The vegetable fibres include cotton, linen, bast, jute, and the like. On the part of synthetic fibres, there are those based on regenerated cellulose, hence cellulosic in nature, for example, viscose rayon. There are those that have amine groups like wool, for example, nylons having amine linkages and so can be regarded as protein fibre in its dye-ability. Acetate and polyester fibres are neither here nor there, and so they require a special kind of dyestuff, consisting of the disperse dyes.

*ii.* ***The dyestuff*** to be used is determined by the specific fibre being dyed and by the fastness properties desired. The direct dyes have an affinity for cellulosic fibres and regenerated fibres. Same goes for the vat dyes which are extensively used to produce very fast colours on cotton and viscose rayon in all forms. The acid and basic dyes have a high affinity for woolen fabric and protein fibres. While disperse dyes are used to colour the synthetic fibres such as polyester and nylon fibres. In every case, there must be some kind of affinity between the fibre and the dyestuff.

*iii.* ***The medium*** in which the dyeing is to be carried out. Water is the medium in which almost all dyeing is carried out. The purest type of water is distilled water but alternatively, rainwater is also good. Chlorine, lime salts, iron and other metals present in the water may have a retarding effect upon the affinity of the dyestuff for the material. There is also the danger that impurities such as colloidal particles, organic matter and sediments, can combine with the dyestuff in such a way as to render it unsuitable for use. In that case, they must be removed by filtration before the water is used for dyeing.

### 2.2.6 Textile fabrication

The finished cloth is used to make different kinds of apparels, domestic and industrial products. The textile mills usually manufacture products like towels, sheets, draperies and blankets, while seamstresses, garment makers and tailors make apparels, garments and more complex domestic wares. Fabrics must be laid out carefully before cutting. Since any defects created while cutting the fabric might be taken into other operations and up till the final product, accuracy is important at this point. Sewing simple industrial and domestic products, however, are relatively straightforward. Thereafter, crisped edges may be created on the fabric by pressing the final product flat.

## III. Futuristic "Knowledge-based" Textiles

Concerns overdeterioration caused by chemical and microbial attacks; exposure to pesticides, pollutants, ultraviolet light and most recently, climatic changes due to air pollutants and direct and extreme heat from the sun causing heat waves and too much perspiration, have increased the demand for futuristic, responsive, self-styled form-fitting garments. These garments are produced with materials now called *"knowledge-based"* textile materials (Jocic, 2012).The *"knowledge-based"* textile materials, therefore, can be described as those materials that have in-built functionalities, otherwise also called *"functional textiles",* whose single goal is to take up futuristic body-friendly capabilities. By this, such functional textiles are designed ab-initio from fibre to finishing, adapting to the body and the surrounding environment by responding in a friendly manner. They are also meant to redefine the role of modern textile materials by expanding their capabilities thereby fulfilling advanced expectations of modern lifestyle. For the purpose of producing these "knowledge-based" textile materials, functional finishing is one of the new advancements in textile finishing that is used to provide a technical bridge for achieving 21st-century textiles. However, most functional finishing technologies employed in the textile treatments industry today involve nanotechnology and the direct inclusion of functional agents to textile materials. Examples of functional agents are antimicrobial agents, water repellents, self-cleaning surface finishes, anti-crease agents, fire retardants, fluorescent whitening, and UV-blockers, mentioning but a few.

## IV. Functional Finishing Used in Advanced Bio-Textiles

Functional finishing has been achieved through design and modelling of three-dimensional textile formation, computer-aided weaving and the application of now environmentally-friendly surface finishes (Stegmaier, 2012). In most cases, this is done using responsive polymeric systems as reported by Jocic (2012). Pavlini, 2013, reveals that functional textiles play a very significant role in human life (Pavlinic, 2013) as they ensure man's comfort and protection. Regardless of environment and work type, these textiles touch human skin; and it therefore makes sense that the textiles placed next to the skin surface accomplished some functions. Some of these functions are to prevent the infections by means of therapeutic, healing, antibacterial and antimicrobial effects; and sweat management. The foremost is essential in medicine where a patient's body is wrapped in different textiles with the aim of cooling or heating it, or maintaining the body temperature. These functions are achieved by integrating responsive thin polymer layers surface-modifying-systems (p-SMS) as micro and bulk hydrogels into textile materials.

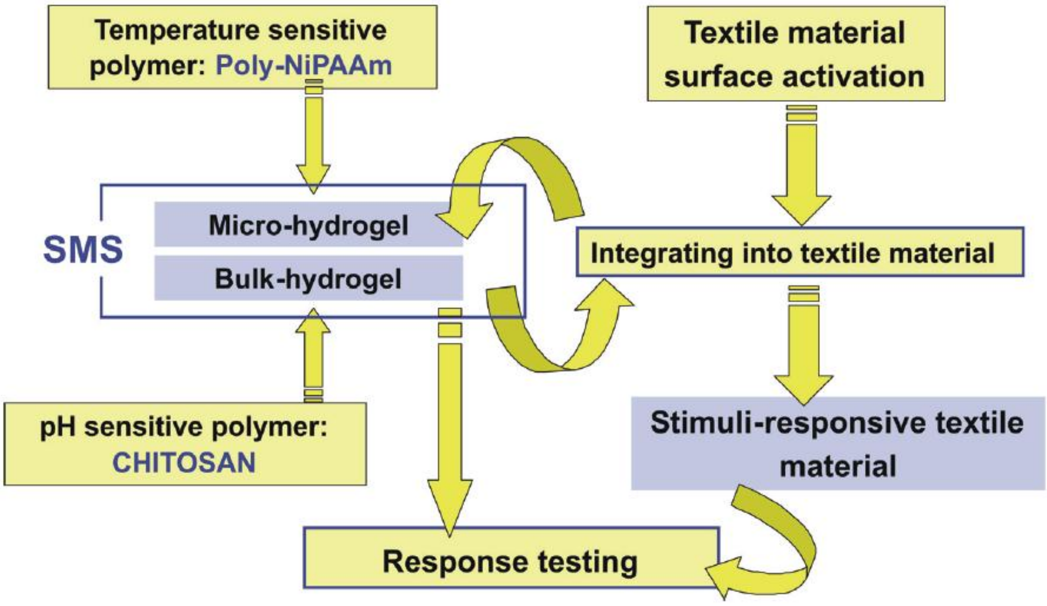


***Figure 1:*** *Plan for making functionally advanced bio-textiles* (Jocic, 2012)

The choice of hydrogels as surface-modifying-systems (p-SMS) incorporated into textile materials is due to their volume phase-transition — contracting or swelling in response to environmental or external conditions such as humidity, temperature and pH — especially when so close to the human body. The various kinds of stimuli-responsive polymer fibres and the corresponding macroscopic responses are presented in Figure 2.

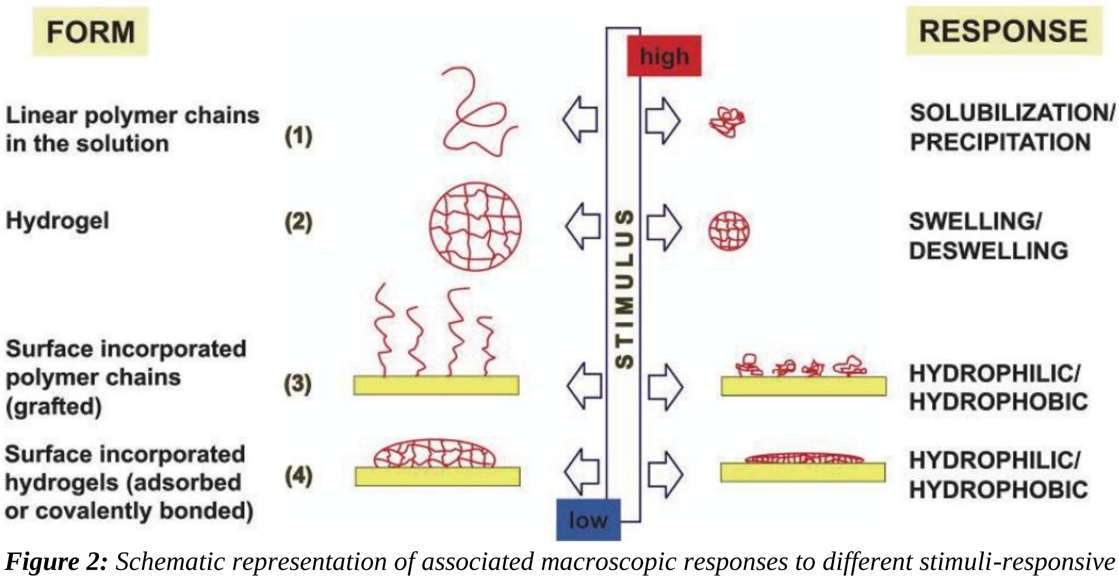


***Figure 2:*** *Schematic representation of associated macroscopic responses to different stimuli-responsive polymers* (Jocic, 2012)

## V. 5Nanotechnology and Nano-coatings in Textile Finishing

Nanotechnology is the utilization of structure and energies inherent in materials at the atomistic level, at the dimension of $10^{-9}$nm, to build novel materials with enhanced performance properties(Shaffer & Sandler, 2007). As in other fields of study, the use of nanotechnology in textile finishing has helped in improving quality and performance of textile materials by giving new and more sophisticated functionalities to textile substrates as well as enhancing the existing functionalities such as durability that sustains the fabric's feel and texture. This comes with a very small amount of chemicals and wet treatment. The science and technology of use of some of the profitable nano-finishes that give antimicrobial, hydrophobic, super-hydrophobic and self-cleaning properties have been studied. The ability of metal oxide and metal nanoparticles to interact with micro-organisms and light has impacted desired effects in textile materials. In the same vein, zinc oxide (ZnO) nanoparticles of average particle size 38±3nm, have been applied variously in the surface modification of textiles. In their work, Yadav and co. 2006 (Yadav et al., 2006), studied the effect of ZnO nanoparticles made from sodium hydroxide and zinc nitrate with soluble starch as the stabilizing agent, on UV blocking and air permeability of cotton fabrics. Bleached plain weave cotton fabrics were coated with the synthesized ZnO nanoparticles. And it was found that the coated fabrics appeared to be more capable of being permeated by active UV blockers and air.

Recently, attempts have been made to make $TiO_2$ immobile on textile fabrics with the objective of producing materials imbibed with multifunction properties. However, the low binding energy between some of the constituent fibres and the $TiO_2$ nanoparticles have restricted their application to fabrics. The high availability, low cost, non-toxicity, biocompatibility, and exceptional photocatalytic activity of $TiO_2$ nanoparticles are the associated advantages of $TiO_2$ nanoparticles over other nanoparticles for their use in the manufacture of various high value-added fabrics (Radetić, 2013).

Shateri Khalil-Abad and Yazdanshenas (2010), reported a simple, easy and effective method of preparing super hydrophobic cotton textiles using silver nanoparticles. They deposited silver nanoparticles on cotton fibres by treating the fibres with silver nitrate ($AgNO_3$) and aqueous potassium hydroxide (KOH), followed by a reduction treatment with ascorbic acid in the presence of a polymeric steric stabilizer to produce a dual-size surface roughness. The silver-nanoparticle-containing cotton textiles are then transformed into hydrophobic surfaces by an additional treatment with octyltriethoxysilane (Shateri Khalil-Abad & Yazdanshenas, 2010). However, some of the setbacks associated with nano-silver finishing are the high cost of processing precursors, incompatibility to aqueous systems and the tendency to cause discoloration in the host fabrics. Therefore, in terms of use and commercialization of nano-finishing, consideration is given to the use of nanoparticles that are safe during their life cycle—production, application, consumption and disposition.

## VI. Other Textile Surface Modifying Techniques

### 6.1 Surface finishing using hydrolyzable silanes

Amino functional silanes and hydrolysable silanes are stable aqueous emulsions, useful as finishing agents for textiles are prepared by adding at least one hydrolyzable functional silane or more to an aqueous emulsion containing an amino-functional siloxane that contains an average of at least two amino functional groups per mole, and in some cases, a hydroxyl (OH-) terminated siloxane. The emulsions confer on textiles durable properties such as compression resistance, softness, slickness, hydrophilicity, or water repellence. This has been patented by Yang, 1991 (Yang, 1991). Functionalization is achieved first of all, by introducing surface alkoxides, *(Fibre-O-Na)*, on the fabric surfaces by treatment with sodium hydroxide solution thereby improving the hydrophobicity of cotton fabrics. In furtherance to this effect, success has been achieved on non-wettable surfaces with high water contact angles (WCAs) and smooth sliding of water beads, referred to as ultrahydrophobic or superhydrophobic (Ma & Hill, 2006). This has been achieved by Xue, Jia, Zhang, & Tian, (2009), where they coated epoxy-functionalized cotton fabrics with amino- and epoxy-functionalized silica nanoparticles to create a dual-size surface roughness, and hydrophobizing them with stearic acid, perfluorodecyl trichlorosilane, or their combination (Xue et al., 2009).

### 6.2 Enzymatic surface modification of textile materials

This is concerned with the processing of fibres or biopolymers to alter their chemical and physical surface properties to enable the adsorption, covalent bonding of functionalities, entrapment / immobilization, and encapsulation of moieties on textile material substrates. This process is aided by biological catalysts called enzymes. Some of the enzymes used in surface modification of textiles during finishing include; xyloglucan endo-transglycosylase, pectinases, cellulases, cutinases and tyrosinases (Nierstrasz, 2009).

In contrast to the conventional chemical finishing treatments given to natural fibres, the use of enzymatic processes offer a non-polluting and effective alternative because enzymes do not generate any harmful by-products, are non-toxic, are substrate-specific, operate under mild conditions, and are biodegradable. As a result, enzymes have an age long tradition of being used in textile wet processing. Enzymatic de-sizing, bio-scouring, bleaching, bio washing and bio-polishing of cotton are well established commercial technologies (Schwausch, Carvajal, McDaniel, & Wales, 2010), and scaling up the production process for this type of finishing has been achieved through biotechnological methods (Schwausch et al., 2010). *Figure 3* presents process routes for achieving enzymatic treatment in conventional processing of cotton fabrics, while *Figure 4* is a scheme showing methods of enzyme immobilization after treatment.

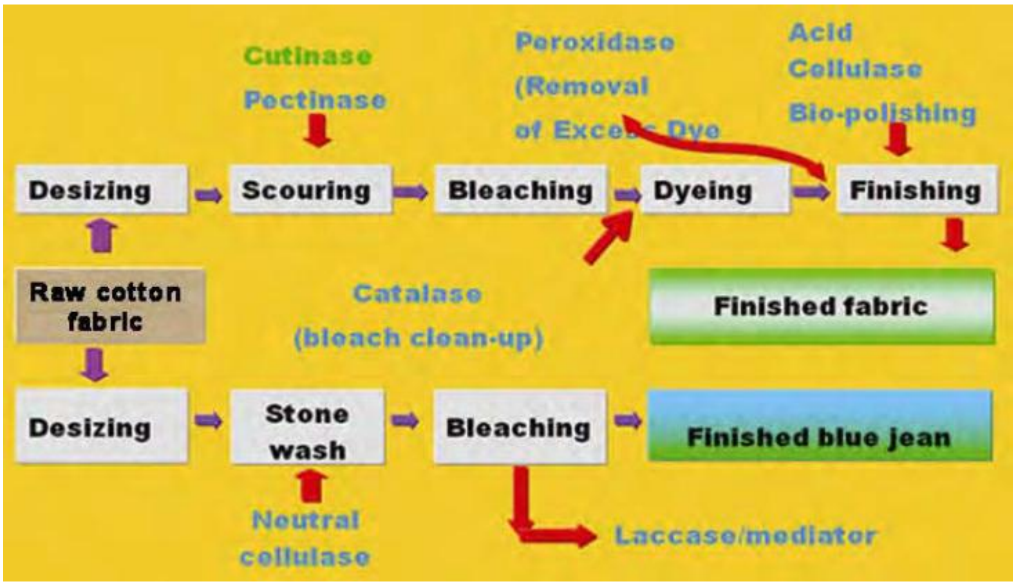


***Figure 3:*** *Conventional application of enzymes in cotton processing* (Gulrajani & Gupta, 2011)

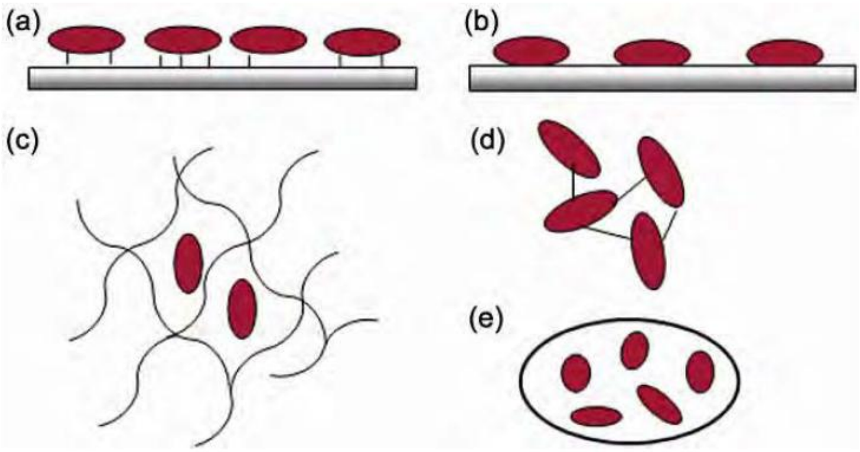


***Figure 4:*** *Methods of enzyme immobilization; (a.) covalent bonding, (b.) adsorption, (C.) entrapment in gel, (d.) intermolecular crosslinking, and (e.) encapsulation* (Gulrajani & Gupta, 2011)

### 6.3 Clay finishing and composite fibres

As a result of the nature of clay microstructure, clay materials are being exploited in textile finishing with the view of taking advantage of their microstructural layer by layer properties in finishing of technical textilematerials into composite fabrics. Polymers reinforced with 2–5 weight per cent of nanoclays showed substantial improvement in flame retardance, barrier properties, dimensional stability and to some extent electrical properties (Gilman, 1999; Manias, 2001; Pavlidou & Papaspyrides, 2008). Improving the mechanical properties of polypropylene thermoplastics using functionalized nanoclays, especially montmorillonites (MMTs) have received significant research interest (Qin, Zhang, Zhao, Hu, & Yang, 2005; Smart, Kandola, Horrocks, Nazaré, & Marney, 2008). The commercial viability of nanoclays is primarily attributed to their reduced cost, wider applicability to most synthetic polymers, polyethylene, polypropylene, polyethylene terephthalate, polyamide fibres (nylon 6,6 and 6,10), and performance enhancement associated with the end product. However, composites applications in the form of fibre, filament or fabric, have not gotten much notice either in research or application.

### 6.4 Microencapsulation finishing

This type of finishing has been patterned in order to introduce such properties as thermoregulation, aromatherapy and fragrance release, de-odorising finishing, biocides, anti-soiling agents, insect resisting finishing like the insecticide-impregnated mosquito nets, UV protection, anti-static properties, soft feel and chemical protection.

## VII. Aerodynamic dyeing

Aerodynamic dyeing or *"Jet dyeing"* basically refers to the mechanism of dying which is based on the application of dyes on substrates by air flow or advanced spraying mechanism. The air-flow is generated by a fan as a special force that atomizes the dye molecules while the fabric runs in the machine. This mechanism of dying is one of the recent sustainable dyeing solutions which aims at reducing water, energy and chemicals (WEC) during textile processing which is greatest in textile finishing compared to yarn spinning and fabric production – weaving and knitting. As against the conventional winch, jig and paddle dyeing techniques, the aerodynamic dyeing technique uses low WEC due to the use of high-fixation reactive dyes with reduced salt, which is able to boost dye fixation rate up to 90%. They are also referred to as low liquor ratio (LLR) "jet" dyeing machines. The advantages of this type of dyeing include; reduction in process time, reduction in total water, energy and chemicals (WEC) consumption, fabric quality is greatly improved as fabric creases as a result of squeezing is eliminated and process errors are drastically reduced.

## VIII. Conclusion

Finishing in textile processing has hugely evolved beyond its earlier conventional *batch-wise* or *exhaust*processes to more advanced innovative techniques using aerodynamic dyeing process in order to reduce waste water, energy and chemicals. Furthermore, nanotechnology which introduces smartness to the textile fabrics has also improved textile appearance and quality to a reasonable extent. Call them functional textiles, *"Knowledge-based"* textiles, *"smart"* or *"intelligent"* textiles, with multiple functionalities and many desirable properties, will definitely become the textiles of the future. This has opened a new wave of opportunities for the textile and apparels industry. However, having x-rayed some of the recent advancements in textile finishing, there are obvious challenges in terms of cost and volume of production, cost of the end product, and environmental friendliness. Hence, there is the need to create better advanced techniques that are as both cost-effective to the producers as they are to the consumers, and still offer durability, good appearance, softness-to-feel, self-cleaning, warmth, anti-soiling, and comfort, for the apparels/textile and automotive industry.

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