NANOTECHNOLOGIES AS IMPROVEMENT OF FASHION TEXTILE DESIGN

Tatiana LASCHUK; José NASCIMENTO & Fernando OLIVEIRA

Abstract:

A concept of dressing in a comfortable way together with technology will soon become the "high point" of the fashion trends in the world. Great apparel companies and textile industry are investing in research of new processes, products and fabrics to supply consumers expectations adding value to the clothing. However, the main focus is to add intelligence to clothing so that it can become multifunctional. The objective of this study is to review and demonstrate the application of smart fabrics in fashion apparel design, based on nanotechnology. It was verified that such application aims to adjust the aesthetic aspects to the technology, to develop clothes which supply psychological expectations and the physiological needs of its users.

Keywords: *Nanotechnology, apparel industry, clothing functional, fashion design.*

1. INTRODUCTION

1.1. History

The 20th century has revolutionized the textile industry, beyond the development of news fibres (mineral, synthetic and modified) and news process (chemical and biological). However, the short period of the 21st century that we have lived has shown a series of discoveriess which can provide a new revolution on apparel industry; this revolution is being realized by nanotechnology. The developments in nanotechnology have potential to inspire advances on textile surfaces, in a higher level of precision. The applications of nanotechnology on apparel industry is still recent, but we can see many companies making use of this technology in a large range of clothing applications, that is even closer to the final consumer.
The research developed will focus on the potential of nanotechnology in a manner to improve consumer's life as well as supply their expectations about clothing, showing the possibilities of application of nanotechnology on apparel field, as well as the processes used on the redesign of textiles surfaces. Nanotechnology is designated as the science that operates at a molecular level; the prefix nano denotes a factor of one-thousand- millionth, represented by nm or 10^{-9}m. The symbolic beginning of nanotechnology can be found on a lecture to the American Physical Society in December 1959, by Richard Feynman entitled: "There is plenty of room at the bottom", he gave an example from nature, comparing the small number of atoms encoded with countless bits of information in DNA, providing the informations on how 'manufacture' a human being [1]. By the end of seventies, nanotechnology was born, with the creation of instruments of controlled visualization and manipulation of atoms and molecules.

1.2. The nanotechnology on textile field

The nanotechnology applied in textile industry is still recent. Worldwide forums directed to textile manufacturers about nanotechnology are happening the understanding of the purpose of this science. By this way the nanotechnology let fabrics to obtain special properties like: anti-microbial, anti-UV, self-cleaning, nanocapsules of moisturizing agents, deodorizing, repellent, and others. This potential on textiles has increased continually, because the commercialization of nanotechnology continues to grow worldwide [2,3].
Currently, material innovation is an important focus on creativity in textile field and many fashion designers consider technological fabrics the future of fashion [4]. The leading research and advisory firm Lux Research, has announced some findings about nanotechnology in the Nanotech Report, 4th Edition. The nanotechnology has incorporated into $32 billion in manufactured goods in 2005 – more than twice than the previous year. In 2014, $2.6 trillion in global manufactured goods will incorporate nanotech, or about 15% of total output [5].
Nanotechnology as an improvement of textiles is an answer to consumer expectation about products. During the creation of consumption products, aspects like comfort, simplicity and aftercare should also be taken into consideration. As Matilla mentioned: "Retailers and consumers are asking more and more for functionality, for added values like appearance and improved comfort" [6].
Nowadays, the nanotechnology is the study of design, creation, synthesis, manipulation, and functional application of materials, apparatuses and systems through of the control and operation of phenomena and properties of the materials on nanoscale [7]. With the aim of demonstrating the application and the potentials of this new science, this paper shows the new developments and research of the nanotechnologies applied to fashion design.

2. NANOTECHNOLOGY AND THE FASHION DESIGN

On textile field, nanotechnology provides new characteristics to fibers, yarns and fabrics. Nano apparel products have already emerged in the market and the number of products which utilize nanotechnlogy is increasing [8].Through this technology it is possible to view new functionalities to the fabrics, like:

- Hydrophobic or hydrophilic, anti-stain, no-wrinkle;
- Eco-compatible and non-toxic;
- Self-cleaning;
- Multi-functional fibers (with thermocromatic microcapsules, anti-microbial and flame-retardant)
- Shape memory and others [9].

Without nanotechnology, these applications wouldn't be possible. For example, if silver particles (which are anti-microbial) were applied without nanotechnology, the touch of the fabric would be impaired. [8].
The nanotechnology products can be obtained by following processes:

- Production of fibers (nanofibers by elesctrospinning or nanoparticles on fiber);
- Plasma treatment (modification of surface in nanometer scale) [10,11];
- Nanoparticle, nanocoating and nanocomposite: Sol-gel process, Layer-by-layer deposition, Physical Deposition of Vapour (PVD), Chemical Deposition of Vapour (CVD) [11].

2.1. Nature as source of inspiration

The innovation in textile is not purely scientific and technologic but can also be inspired by nature. An example is the finishing with nanosphere, which improves the performance of traditional fibers. Some these technologies are based in the self cleaning properties of the lotus leaf (Fig.1) [2].

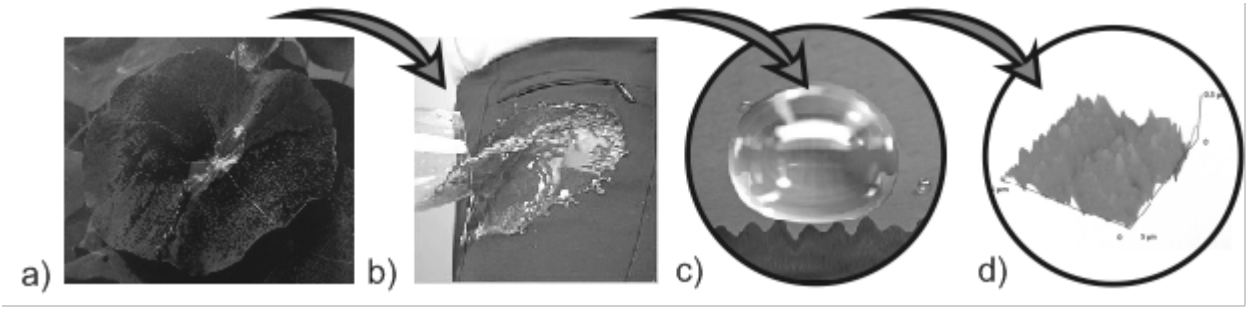

Figure 1 – a) Lotus Leaf, b) fabric with self cleaning properties (nanosphere), c) roughness surface of the lotus leaf d) Surface roughness in nanoscale of the lotus leaf by AFM (Atomic Force Microscopy) [2].

The biomimicry studies the nature of materials behaviour and applies it to solve contemporary problems; these have been associated with development of new products with multifunctional properties, as it can be seen in Morphetex example, which began a research in 1995 with Nissan Motors and Tanaka Kinzoku Kogyo [13].
Morphotex yarns reproduce the subtle shimmer of butterfly wings and has used 61 layers of polyester and nylon alternated that reflect light and can express different colors in accordance with the angle and strength of light. Most of the products are used for apparel including denim and women's (Fig.2).

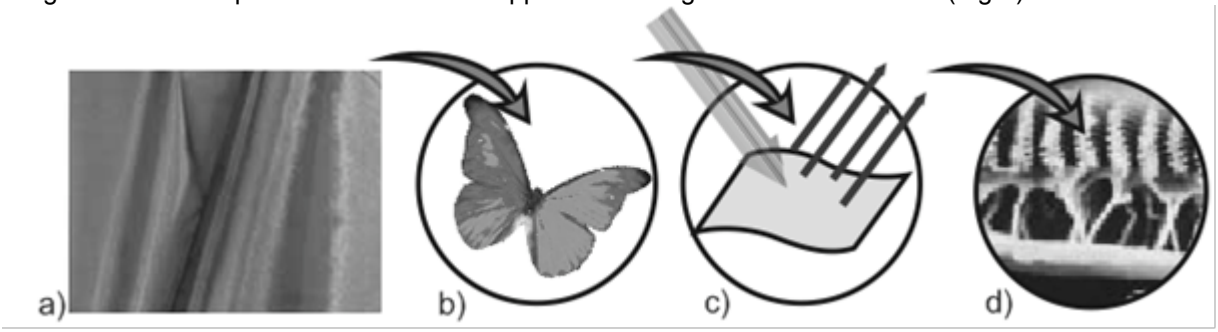

Figure 2 – (a) butterfly wings, (b) butterfly wings microstructure By SEM (Scanning Electronic Microscopic), (c) simulation properties of the butterfly wings and (d) fabric with properties of the butterfly wings [13].

2.2. Functional fabrics

Several fashion designers of important brands like: Adidas, Hugo Boss, René Lezard, Brooks and Brothers and Paul Stuart have been using fabrics with self-cleaning treatment for high-end trousers, shirts and outerwear [14,15]. The fabric is manufactured with self cleaning treatment, without alteration of touch, manteining its physical properties. Liquids like wine, juice, coffee, and salad dressing roll right off, providing long-lasting protection. Besides, it allows the fabric to breathe naturally [17]. The Fig. 3 shows the self cleaning process behaviour.

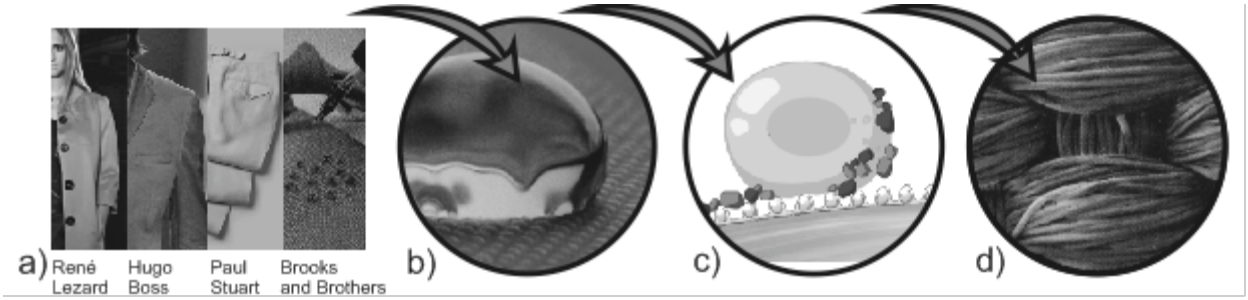

Figure 3 – Self Cleaning process: a) Clothing with treatment, (b) Liquid above the fabric with treatment (c) Removal of the dirty (d) SEM (Scanning Electronic Microscopic) of the fabric with finishing [15,16].

There is another type of self cleaning finishing, which produces a nanoporous film. It is produced by silicone or PTFE (polytetrafluoethylene), these polymers are suitable for applications on fabrics used in outdoor and exposed in environmental conditions like rain and dust. The principle of effect in nano scale prevents the formation of bonding forces between a particle and the textile surface. [19].
Several companies in performance apparel and sports gears have invested in nanotechnology researches with the aim of developing smart textiles. They develop products, which are quick-acting moisture wicking fabric enhancement which pulls perspiration away from the skin to keep the body cooler, dryer and more comfortable to add a new level of comfort to shorts and pants. The treatment is formulated for resin-treated on cottons and synthetics fibers.This technology balances the body temperature, enhancing comfort, allows the breathability of the fabric and retains its natural softness [18].

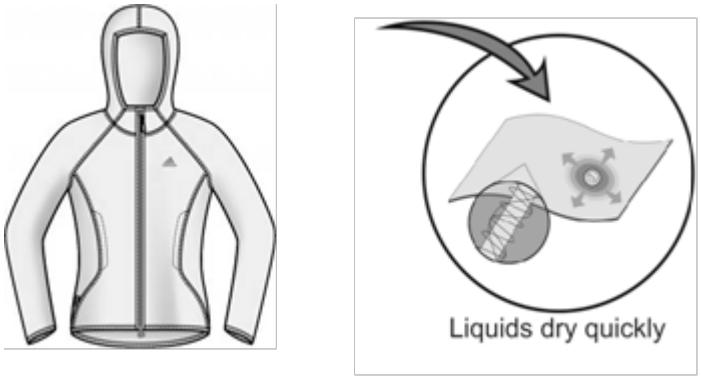

Figure 4 – Prototype with breathability properties[18].

2.3 Cosmetic Fibers

As an example of the new active generation of functional clothes at the center of this innovation, there are some key brands. Intelligent clothes fitted with nanoparticles recognize sweat, catch it and prevent unpleasant aromas developed within the textile. There's even a variation on nanoparticles that will release fresh smells into the air as soon as you start to get sweaty and all of this is achieved through naturally based substances. The cyclodextrins can be embedded in the fabric with a permanent base (Fig.5). The resistance related to the number of washing processes realized of the cyclodextrin depends on the material used [19]. The application is done during finishing by foulard system. Nanoparticles work like tiny cups, enclosing the organic components in the perspiration that cause the smell [21]. This treatment can be made on cotton, linen, viscose, polyester/ polyamide/polyacrylic, wool, wool mixtures [20].

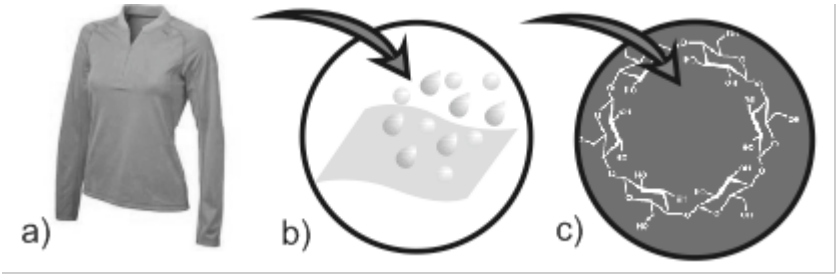

Figure 5– Prototype (a) with fragrances released properties (b) and the molecular structure of cyclodextrins (c) [20].

There is another innovative technology, which adds extra values to clothes and tolerates several washing. The fabrics are filled with high-grade ingredients and, over time, they are slowly released onto the skin. A layer of Chitosan protects each capsule, saving its contents from warmth, drying out and the cold and giving it durability against the wear and tear of day-to-day life. At the same time, Chitosan has skin-caring attributes. It helps to protect the skin from dehydration and to keep a supple and velvety soft feeling. When you wear clothes fitted with this technology, the ingredients are released through physical and chemical mechanisms [13].
Miss Sixty, a known fashion brand is using microcapsules technology to reduce cellulite, the slimming actives directly from the clothes (Fig. 6) [22].

Figure 6 – Prototype with active ingredients[21].

2.4 - Thermoregulator

Nanotech thermoregulator fabric developed by Klimeo® contains microcapsules with temperature-regulating ingredient which are applied in and on the fabric using prolectron. The temperature-regulating ingredient is a phase change material that, when the capsules meet cold, they go solid and impenetrable and will not let the cold through, but when they meet warmth, the capsules go liquid and allow the heat to pass through. Klimeo® does not change the fabric's properties or aspect, which can always be adapted to the latest fashion trends [24]. Autumn/Winter 2007 Sunwill collection has used Klimeo to add value to their clothings and has mentioned Klimeo technology as "built-in air condition" referring to the new technology applied.

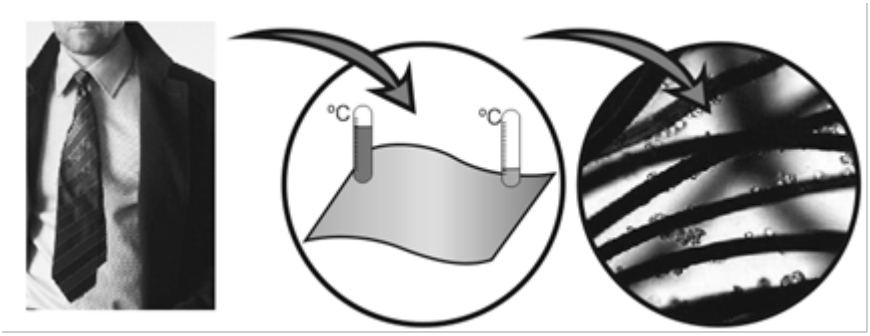

Figure 7. Klimeo technology, a nanotech thermoregulator [24]

2.5 Aesthetic effect and Anti-microbial Nanocoatings

Several metallic particles are natural antimicrobial in nanometer scale. Applied in the fabrics, protect the user against some bacteria, fungus, virus and reduce the necessity to wash. With the purpose of making clothes that have this functionality, a lot of researches have been made. The research group of the University Cornell [4,23] has added in cotton fabric nanoparticules of palladium and silver by electrostatic self-assembly with excellent results.

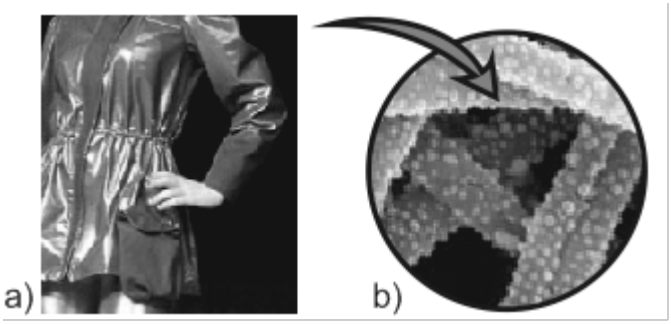

Figure 8 – (a) Jacket with palladium nanoparticles and (b) SEM (Scanning Electronic Microscopic)[23].

The aesthetic effect can be obtained when the substrate is covered with different nanocoating (layer-by-layer) of materials with different refractive index. These 50 layers have 70nm of thickness and refract the light creating differential tones and intensities according to the position of the observer and incidence angle of the light. Process can be applied by sol-gel. The opal effect can be formed by silica monodispersed spheres of about 250 nm with structures highly ordered with crystalline zones.
Nanoparticles shrunk in coverings creates effect luminescent photo. (silic acid polyoxometalatos, salts, alkaline-earth aluminate). The crystals absorb the light and they emit it in the dark (Fig. 8) [7].

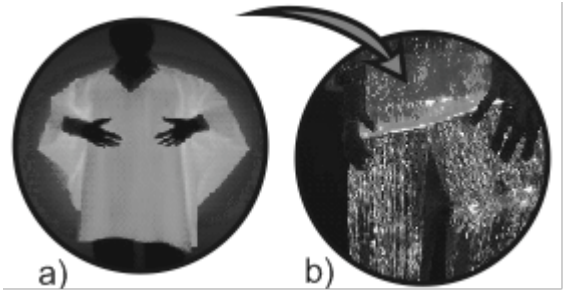

Figure 9 – Photoluminescence effect: (a) protection (b) application on pants [7].

3. CONCLUSION

The application of nanotechnology on textile field is increasing fastly in a large scale. This situation is a consequence of consumers needs and desires, since they are looking for multifunctional products that are more appealing and functional. The apparel manufactures are answering for this requirements applying new technologies like nanotechnology to create smart fabrics with added value. This fabrics are having a great impact on functionality and performance of the fabrics, and will be a source of inspiration to this fascinating new field of business, generating exciting developments and exploring their implications.
We can observe that nanotechnology´s applications has as main focus on sportwear, workwear and menswear field and the fashion apparel is becoming an interesting area to be explored.

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