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NANOTECHNOLOGY IN TEXTILES

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ABSTRACT

Nanotechnology, a broad scientific field dealing with surface science, organic chemistry, molecular biology, semiconductor physics and micro manufacturing etc. The use of nanotechnology in textiles industry has been increasing rapidly due to their unique and valuable characteristics. There is a significant profit potential applications of nanotechnology in cotton and other textiles industry sectors. Its application can prolong the economical properties and values of textile processing and products. The use of nanotechnology creates textiles multifunctional and produce fabrics with special functions, including antibacterial, UV protection, easy-care, water- and dirt-repellent and odor-resistant. Smart Textiles based on nanotechnology are specifically designed for military purposes to monitor the stress and failure in the human body during combat conditions. In addition, nylon nanofibers are used as protective clothing for filtration applications, while Fiberglass and carbon nanotubes are commonly used in the air filtration industry. However, the technically manufactured nanomaterials cannot be ignored by human health and environment Perspective that suggest appropriate consideration in obtaining benefit from this technology.

Keywords *– Nanotechnology, Textile design, Smart textiles, Multifunctional textiles, Sensors*

1. INTRODUCTION

Rapid development and lifestyle changes have attracted people towards a more comfortable and luxurious life. people are evolution towards small, safer, cheaper and fast working products which not only reduces the workload but also helps them to carry get their jobs done much faster with minimal effort. Devices have been developed that are much smaller size such as microchip, nanocapsules, carbon tubes, memory cards, USB sticks, etc., which reduces transport problems, and storage and are also much faster and more reliable than we can do more of our work in less time.

Throughout history, the textile sectors have been exploited in a variety of consumer applications worldwide. Naturally fibers such as cotton, silk and wool as well as synthetic fibers, such as polyester and nylon, are still the most common fibers for clothing manufacture. Synthetic fibers are mostly suitable for household and industrial applications, such as carpets, tents, tires, ropes, belts, cleaning cloths and medical products. Natural and synthetic fibers generally have different properties that make them particularly suitable for ideal dress. Many textile materials such as cotton, silk or polyester are ideal substrates on which intelligent, functional ones can be integrated nanomaterials.

Various approaches have been developed for integration nanomaterials in textiles. The bottom-up approach is used in the manufacture of the fibers that make up the fabrics manufactured. In contrast, the “top-down” approach is used in finishing, for example through printing technologies, spray coating or impregnation. Electrospinning is a relative new method of manufacturing fibers and fabrics from processed raw materials and has proven to be ideal for processing nanofibers. In coating technologies, various organic and inorganic compounds can be classified as particles in the nanosize range and can be used directly.

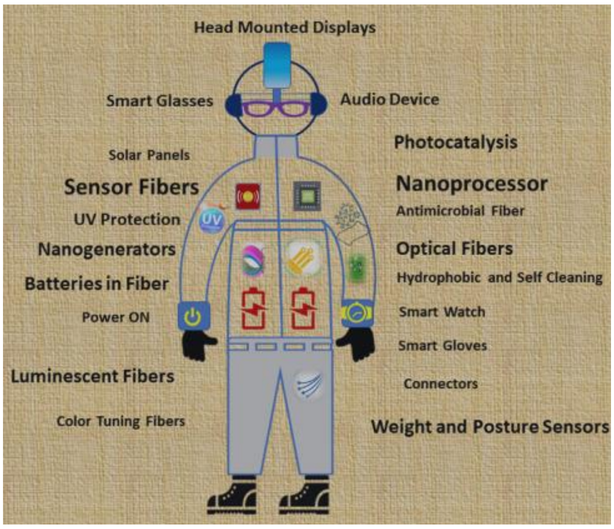

Fig 1: Futuristic smart clothing made from nanomaterial Processed fibers for on-body multifunctional devices.[1]

- Required Components for working of nano sensor.

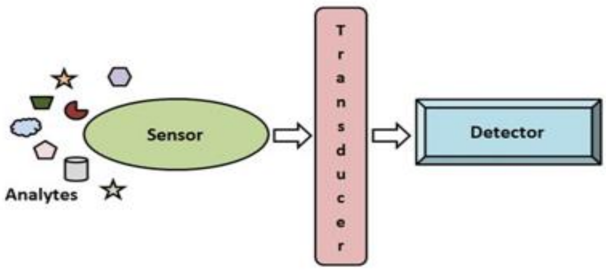

Fig 2: Components of nano sensor. [2]

Fig. 2 shows the components of nanosensors the ability to measure down to the point of the single molecule even. The components of nanosensors include an analyte, sensor, transducer (a device that is a form of energy to another) and detector. Mostly nanosensors work by tracking the electrical changes in the sensor materials. The analyte diffuses from the solution into the surface of the sensor and reacts in a targeted and efficient manner, this changes the physio-chemical properties of the transducer surface, which leads to a change in optics or electronic properties of the surface of the transducer, this change is converted into electrical signal, i.e., accepted.

- Optical nanosensors measures change in light intensity
- Electrochemical nanosensors measures electric changes.
- Piezoelectric nanosensors measures changes in mass
- Thermal nanosensors measures heat changes.

2. TECHNOLOGIES

In terms of “conventional” textiles, modern fabrics became developed that show a high level of performance in terms of hydrophobic (wearing comfort), UV resistance, antimicrobial, anti-static, wrinkle-resistant, stain-resistant, or shrink-resistant properties. However, these are “passive traits” and researchers are interested in incorporating new manufacturing and surface finishes. Methods for using nanotechnology to imprint intelligent and innovative applications. Their main motive is to introduce new things applications with high efficiency without compromise Comfort, flexibility and light weight of the fabric

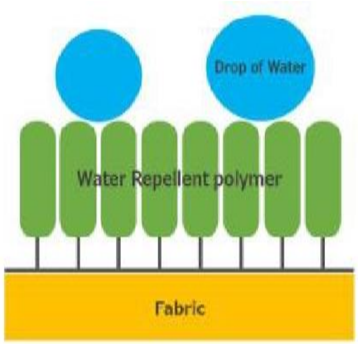

Fig 3: Water Repellent layer [3] **Fig 4: Water Repellence [5]**

Nano-Tex improves the water-repellent properties of the fabric creating nano-whiskers that are hydrocarbons and 1/1000 of the size of a typical cotton fiber added to the fabric create a peach fuzz effect without lowering the cotton strength. Fig. 4 shows the difference between normal textile and water repellent nano-textile. Fig. 3 shows the spaces between the whiskers on the fabric which are smaller than the typical drop of water, Thus water remains on the top of the whiskers and above the fabric surface. However, Fluid can still permeate through tissues when pressure is applied. That performance is durable while maintaining breathability.

Figure 5 shows the protection against UV radiation for textiles with nanotechnology. The UV protective materials are obtained by treating fabrics with UV blockers (UVB and UVA radiation) nanomaterials to enhance UV radiation shielding. The UV protective effect is measured by UV protection factor (UPF) and depends on the composition of the substance. UV-responsive nanomaterials such as TiO_2 and ZnO are able to scatter or absorb UV radiation. These materials are non-toxic and can also be stable at higher temperatures. The combination of MnO_2-$FeTiO_3$ nanoparticles with thermoplastic polyurethane cotton textiles helps to block UV rays.

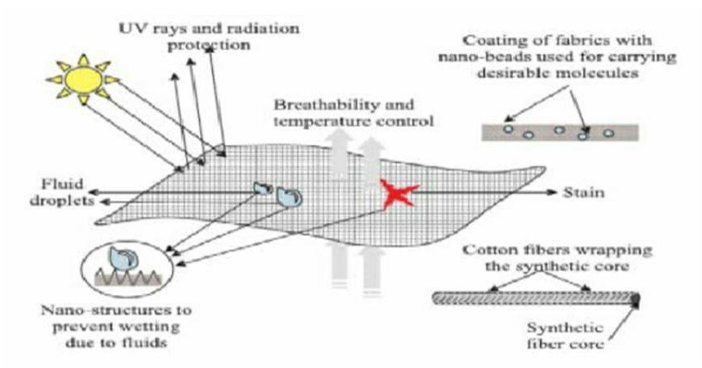

Fig 5: Ultraviolet-resistant Textiles [4]

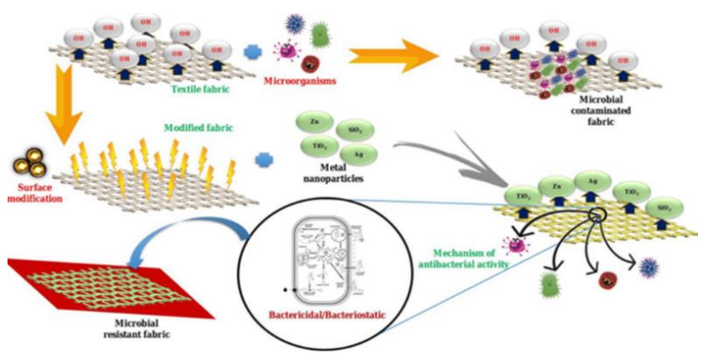

Fig. 6 shows the antibacterial nano-textiles. To mediate anti-bacterial properties, nano-sized silver, titanium dioxide and zinc oxide is used. Metal ions and metal compounds show certain degree of sterilizing effect. It counts as that part of the oxygen in the air or in the water is thereby converted into active oxygen by catalysis with the metal ion, dissolves organic matter to achieve a sterilizing effect. With the help of nano-sized particles the number of particles per unit area is increased, allowing the antibacterial effect to be maximized.

Fig 6: Anti-bacterial Finish [12]

Fig 7: Wrinkle free textiles [6]

Fig. 7 shows the wrinkle-free clothing. Nano-Tex has one new nanotechnology-based wrinkle-free treatment that is said to provide an improved performance while maintaining tissue strength and integrity that offers an alternative to harsh traditional processes. Chemicals and processing methods reduce the substance tear and tensile strength. This means that there are certain substances in garments made of wrinkle-free textiles which are popular and convenient for time-pressed consumers, but traditionally not candidates for wrinkle-free technology, such as lightweight fabrics or tight-fitting clothing.

Fig. 8 shows different types of sensors that can be integrated textile for a variety of applications such as thermal sensors, touch

sensors, pressure sensors, optical sensors, chemical sensors, odour sensors, etc. Carbon-based nanomaterials such as e.g., have carbon nanofibers, graphene and carbon nanotubes (CNT) which have been extensively studied for their use as light, flexible and high strain sensors that can be used in the areas of smart garments, health monitoring and human motion detection. Carbon based nanoparticles have been produced using various techniques and are homogeneously dispersed in polymers for use of strain sensors. Strain sensors were developed by direct film casting and electrospinning techniques.

Fig 8: Sensors on Textile [7]

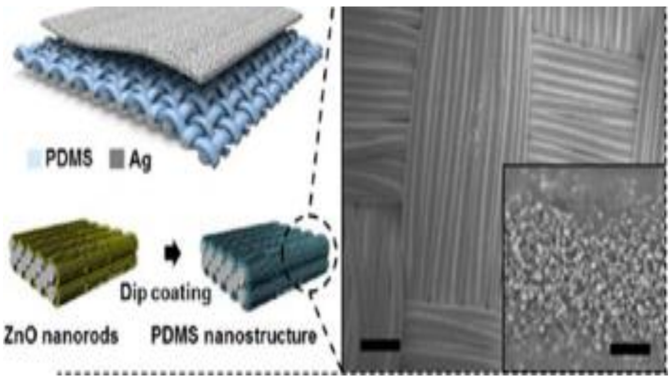

Fig 9: Photonics in textiles [9]

Fig. 9 shows the use of photonic technologies in the fashion, this Fashion industry attracted a lot of attention. The different optics materials namely; optical fibers, optical films and nanoparticles have been used to design various attractive and intelligent textiles fabrics. The goal behind using photonic material in textiles is to tune the look of the dress by modifying the light pattern and color intensity. For example, the optical films that can be developed from periodic dielectric multilayers robust be applied to the textile fibers, which could lead to highly reflective and colorful designs on the fabric when observed from different angles. Holographic film coatings can also be applied to fabrics to create attractive 3D visual effects. Phosphorescent films have also been used on fabrics also makes it glow in the dark. Photochromic and thermochromic materials were used in textiles to sense the temperature changes or light intensity.

Below fig. 10 describes the Future Textiles with all upgrades and requirements for military soldiers needed? Among the major advances made possible by nanotechnology are the development of military-grade active sensor packages for damage detection (Corrosion, substrate integrity, etc.) and environmental exposure conditions (i.e., radiation, chemicals, temperature, gases,

Fig 10: Nanotech uniforms for Military soldiers [11]

exposure, etc.). In addition, nanotechnology will have an impact on combat room systems dealing with information and signals processing, autonomy and intelligence.

Uniforms:

The US Army developed durable with NanoSyntTex nonwovens that incorporate blends of different nonwovens imparting water absorbency or repellency, fire and warmth resistance, antimicrobial treatment, etc. This reinforced multi-layer nonwoven composites have been developed for this to be lighter, significantly more breathable and superior in tear and breaking strength.

Wound Care:

Wound dressings coated with nanomaterials allow control of the release of drugs and proteins for a certain period of time. This unique property of nanoparticle aggregate wound

dressings, the exciting possibility of controlling the release of growth factors and other agents to accelerate wound healing.

Sensors:

Nanomaterials enable intelligent sensor technologies designed to improve military intelligence gathering by soldiers in the field. Chemical and biological nanosensors can be used to detect harmful chemicals and biological weapons. You can also be used as damage detection systems. Physical nanosensors could detect fractures in the military equipment.

Coating:

Military equipment and personnel have to endure a lot most demanding environments on earth. Nanostructured coating technology enables military aircraft and turbines, for example powered vehicles and equipment for uninterrupted operation longer by withstanding these extreme conditions. Scratch resistant coatings have been applied to aircraft cockpits.

3. APPLICATIONS

Fig 11: Applications of Nanotextiles [8]

Fig 11 shows the applications of Nanotextiles, some of them are

1. Electronic Textile
2. Military and combat outfit
3. Jackets, Gloves, caps etc
4. Active casual wear dresses
5. Composite fabrics and materials
6. Camouflage
7. Sportswear
8. Under garments
9. Protective clothing (UV, static)
10. Medical fabrics tissue engineering
11. Camouflage
12. Climate control garments

4. ADVANTAGES

1. Control of crystal structure
2. Quality improvement
3. Improved resistance to chemicals, microbes, flame and heat
4. Retain fabric softness and breathability
5. Light weight.

5. CONCLUSION

There is a significant potential for profitable applications ofnanotechnology in cotton and other textiles. Several applications of nanotechnology can be expanded to achieve that performance increase of textile manufacturing machines & processes.

The properties that are given to textile materials using nanotechnology is updated with its mechanisms. In particular, most Nano-Tex products also have one big workload. In addition, the applications of nano-TiO2 have also been well reviewed and analysed to a good extent. As already mentioned, nanotechnology overcomes that limit of using traditional methods to convey certain properties of textile materials.

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