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A REVIEW ON APPLICATION OF NANOTECHNOLOGY IN MODERN TEXTILES

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Abstract

In the 21st century, nanotechnology is known to be one of the most exciting technology. In addition to creating miniature structures, nanotechnology also provides a scheduled mechanised technology that can provide comprehensive, inexpensive control of the composition of matter. Along with nanotechnology, nanoscience includes the study and application of very small things which can be found in all other areas of research, like physics, chemistry, biology, material science, and engineering. The inconvenience by using conventional approaches to impart such properties to textile fabrics is solved by this technology. There is no uncertainty that nanotechnology will slash through in any field of the textile industry in the coming years. In areas where revolutionary concepts are combined into long-lasting, multifunctional textile systems without sacrificing the intrinsic textile properties, including aesthetics, breathability, versatility, etc., the application of nanotechnology lies in contemporary textiles. With a focus on enhancing the different properties of textiles, the present state of nanotechnology uses in the textile area is being reviewed in current study.

Keywords: *Coating, Nanotechnology, Textile, UV, Whiskers.*

I. INTRODUCTION

The idea of nanotechnology is not new-fangled; it began more than forty years ago. Nano-technology is defined, from the point of view of the National Nanotechnology Initiative (NNI), as the exploitation of structures with at least one nanometer scale dimension for the manufacturing of materials, devices or structures with original or substantially enhanced properties due to their nano-size. In addition to creating miniature structures, nanotechnology also provides an awaited mechanised technology that can provide comprehensive, inexpensive control of the composition of matter. Most notably, nanotechnology can be defined as operations at the level of atoms and molecules that have actual human applications. Nano-particles are commonly used within the range of 1 to 100 nm in profitable goods. It goes without saying that, together, nano-science and nanotechnology have regenerated material science and contributed to the creation and evolution by nanostructuring and nanoengineering of a new variety of improved materials, including polymers and textiles[1].

In all areas of science and technology, like material science, material processing technology, physics, electronics, optics, medicine, electricity and aerospace, plastics and textiles, nanotechnology is a new discipline which is supposed to have wide-ranging implications. While this technology is still in its infancy, it is already proving to be a valuable instrument for enhancing textile efficiency and creating interest worldwide. The innovative application of nanotechnologies to textiles offers an extended variety of properties with potential for new and enhanced product applications. Fresh or enhanced functionalities may be created by modifying or enhancing properties through nanotechnologies. The information given in this review article is not detailed, but represents current national and international studies, including nanotextile commercial activities. The use of processes focused on nanotechnology and nanomaterials in all areas of science and technology is increasing at an unprecedented pace. In its diverse area of applications, the textile industry is also witnessing the advantages of nanotechnology. Nanotechnology integrating textiles beginning from nanocomposites and nanofibers to smart polymeric coatings was developed in different products, not only in high-end applications, but often successfully used to provide new features and enhanced performance in various traditional textiles. With greater repeatability, reliability and durability, the key benefits of nanotechnological developments in textiles are integrated. The working of nanoparticles during the manufacturing of different textiles, such as dyeing, finishing and painting, increases the efficiency of the product manifold and provides unreached functionality[2].

Nano-Tex, a contributor to US-based Burlington Industries, started primary work on nanotechnology in textiles. Subsequently, other textile industries around the world started engaging in different facets of the production of nanotechnology. Coating, for instance, is a common technique used on textiles to add nano-particles. Coating compounds are typically composed of nano-particles, a surfactant, ingredients and a carrier medium that can change the surface of textiles. Coating on fabrics can be applied by many ways, like spraying, transfer writing, cleaning, rinsing and padding. Padding is the most widely used of these techniques. Through the use of a padder calibrated to the required pressure and rpm, the nano-particles are attached to the cloth, accompanied by drying and curing. Water repellence, soil tolerance, wrinkle resistance, anti-bacteria, anti-static and UV defence, flame retardation, enhancement of dye-ability and so on are the characteristics instilled to textiles using nanotechnology. Just some of the excellently properties imparted by nano-treatment are critically illuminated in this article, since there are numerous possible implementations of nanotechnology in the textile industry.

II. DISCUSSION

Nanotechnology in textiles

There are different kinds of recently developed coating methods, such as sol-gel, which can build multi-functional, knowledgeable, excellent longevity and fabric weather resistance layer-by-layer. The present thesis focuses primarily on the enhancement and future applications of nanotechnology in the production of nanotechnology-related multifunctional and smart nanocomposite based fibres, nanofibers and other novel completed and coated textiles. Often addressed is the concept of nano-materials in garment finishing and manufacturing to increase product performance. Nanocoating is a relatively recent technique in the textile industry and is presently being researched and developed. Investigation also revealed that, nanofibers which are sub-micron size in diameter are also gaining much more popularity in specialized technical applications such as filter fabric, antibacterial patches, tissue engineering and chemical

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protective suits. There are different polymeric nanocomposite coatings where nanoparticles are distributed as polymeric media and a promising way to grow multifunctional and intelligent high-performance textiles is currently used for coating applications. The key research field for the development of multifunctional, intelligent fibres is the preparation of nanocomposite fibres, where the exceptional properties of nanoparticles have been used to develop conventional textile-based fibres and to impart many functionalities[3].

Nano-finishes and coatings for advanced technical textiles

In the garment industry, nanotechnology has incredible market opportunities. This is mostly due to the fact that conventional procedures used to give fabrics various properties sometimes do not lead the path to eternal results and, after frequent washing or wearing, may often lose their versatility. Therefore, innovation focused on nanotechnology has opened up enormous possibilities in textile finishing processes, leading to ground-breaking new finishes and new techniques of use. The most important thing is to make chemical finishing more controllable, resilient and increase functionality dramatically by adding different forms of nanoparticles or making nanotechnology-based structured surfaces[4].

Water repellence by nano-whiskers

Nano-Tex produced water-repellent fabric improvement by producing nano-whiskers, where hydrocarbons and 1/1000 of the size of a standard cotton fibre were applied to the fabric to achieve peach fuzz like effect without decreasing cotton fibre strength. The intermolecular gaps on the cloth surface between the whiskers are narrower than the normal water drop, but greater than water molecules. Technically, water lies on top of the whiskers and above the fabric's surface. More specifically, once a certain level of friction is applied, the liquid will also flow through the cloth. Though retaining breathability, the performance still remains persistent at large[5].

UV-protection

Technically, since they are chemically stable and non-toxic under constant exposure to elevated temperatures and UV, inorganic UV blockers are much more superior to organic UV blockers. It is said that inorganic UV blockers are usually semiconductor oxides such as TiO_2, ZnO, SiO_2 and Al_2O_3. Titanium dioxide (TiO_2) and zinc oxide (ZnO) are widely used among such semiconductor oxides. Nano-sized titanium dioxide and zinc oxide have been found to be more effective in processing and dispersing UV radiation than typical sizes and to help block UV radiation. The key explanation for this is that nano-particles per unit mass and volume have a greater surface area than traditional materials, which contributes to an improvement in the effectiveness of blocking UV radiation[6].

Wrinkle resistance

Resin is conventionally used in order to add wrinkle resistance to clothing. There are, however, certain disadvantages about the application of resin, including a reduction in fibre tensile strength, resistance to abrasion, water absorption, dyeability and breathability. For such a purpose, several investigators have used nano-titanium dioxide and nano-silica to enhance the wrinkle resistance properties of cotton and silk fabrics, respectively, in order to address the drawbacks of resin use in textiles. In addition, along with carboxylic acid, nano-titanium dioxide was used as a substrate under UV irradiation to catalyse the cross-linking reaction between the cellulose molecule and the acid. In addition, the application of nano-silica as a catalyst with maleic anhydride demonstrated that the application of nano-silica with maleic anhydride could successfully improve silk wrinkle resistance.

Application of nanosilver for antibacterial nano-finishes

Broad ranges of antimicrobial textile finishes are possible and products have been tested and very a few have been already sold, based to a large degree on the beneficial antimicrobial activities of silver in nanoform. In wound treatment, nano silver particles containing antimicrobial dressings have been integrated and have acquired a wide variety of appropriateness in clinical uses as clean, safe, innocuous and efficient means of managing microbial growth around the wound, resulting in better healing. In addition, nano silver-based medical textiles for health and hygiene protection have also been developed and commercialised[7].

Self-cleaning nano finishes

Different species, like the Lotus leaf, show rare super hydrophobic wetting phenomenon in nature. A super hydrophobic surface is scientifically classified as one that can bead fully off water droplets along with showing water droplet advancing angles at the surface region of 150 degrees or higher. For that cause, because the rolling water droplets around the surface will quickly pick up the soil particles and leave behind a clean surface, a self-cleaning surface occurs[8].

Nano-finishes for antistatic property

Several wonderful approaches to producing super hydrophobic surfaces on textiles have been investigated by observing from nature, imitating the nanostructured Lotus leaf and thereby exhibiting signs of self-cleaning properties[9].

Nano-coatings and electrochemical deposition

An analysis found that, since they absorb a smaller volume of water, man-made fibres like nylon and polyester are vulnerable to static charge accumulation. Nano-sized TiO2, ZnO whiskers, nano-antimony-doped tin oxide (ATO) along with silane nanosol have also been documented to provide human-made fibres with antistatic properties, such that TiO2, ZnO and TiO2 nanoparticles are electrically conductive substances and help push away the static charge in these fibres. Due to their wide surface area, nanostructured surfaces are of considerable interest, which may obtain maximum functionality. Nanocoating relates to the coating of nanometer-scale structures with a sheet (10-100 nm thick) or the covering of a nanoscale object to shape nanocomposites and engineered substances. Recent times, nanocoatings on textiles have been researched predominantly utilizing techniques like plasma-assisted polymerization, self-assembly, nanocoating with sol-gel and electrochemical deposition[10].

III. **CONCLUSION**

The reality that nanotechnology has arisen as the essential technology that has revitalised material science and has the ability to evolve and develop a new variety of intelligent products, especially polymers and textiles, is not to be denied. It is certainly possible to sum up the use of nanotechnology in textiles as a development in the world of scientific textiles. There is a word of warning, though, since industrial marketing of goods based on nanotechnology will become a commercial reality. The problems are described below:

- Mass processing of nanoparticles and manufacturing costs for them.
- Practical impact on the assessment of mechanical suitability for use.
- Effects and effect on public health of unregulated release of nanoparticles in the atmosphere along with the whole ecosystem typically protected under the 'nanotoxicology' sector.
- Establish and adjust test protocols to ensure the comparability of research results on the effect of nano-materials on the atmosphere and their actions.
- Accurate views and ethics on the common use of goods dependent on nanotechnology.

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