APPLICATION ORIENTED NANOTECHNOLOGY IN TEXTILEMATERIAL

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ABSTRACT

The Technology that handles the science and engineering of materials at the dimensions of roughly 1 to 100 nm (1 billion mm=1m)in length is entitled as nanotechnology.In textile, a number of nanosize fillers and their consequent outcomes have been reviewed and found these nanofibres boost the level of textile performance. Nanolayer assembly is a breakthrough which involves surface coating using Carbon Nanofibres.Microstructural examinations proved the ability of CNFs to alter the polymer matrix and modify characteristics such as stain resistance,UV protection, tensile strength, durability etc...Also incorporating CNFs at time of fabrication of glass fibre composites can provide an inventive means of self sensing they will monitor damage propogation in glass fibre composites.

INTRODUCTION:

The prefix 'nano' is derived from the Greek word 'nanos', which means 'dwarf'. Briefly nanotechnology refers to scientific and technological advances that rely on the properties of materials at a very, very small scale. It involves many complex concepts that cannot be seen or understood easily. As nanoscience and nanotechnology cover such a wide range of fields (from chemistry, physics and biology, to medicine, engineering and electronics), they have been considered in four broad categories: nanomaterials, electronics, optoelectronics, biotechnology and nanomedicine. The category of most relevance for textiles is nanomaterials.At the National Nanotechnology Initiative (NNI), NT is defined as the understanding, manipulation, and control of matter at the above stated length scale, such that the physical, chemical, and biological properties of materials (individual atoms, molecules, and bulk matter) can be engineered, synthesized, or altered to develop the next generations of improved materials, devices, structures, advances in applications of NT to improve textile properties offer obvious, high eco- nomic potential for the industry's growth.It was demonstrated in recent years that NT can be used to enhance textile attributes, such as fabric softness, durabil- ity, and breathability, water repellency, fire retardancy, anti- microbial properties, and the like in fibers, yarns, and fabrics.Many attempts have been made to improve their properties for high performance textile fabric composites. Several studies reported considerable improvement in fracture toughness of glass fiber reinforced polymer (GFRP) when fumed silica, carbon black, carbon nanotubes (CNTs) and carbon nanofibers (CNFs) were incorporated in polymer nanocomposites.

Nanomaterials play an important and significant role in controlling the intrinsic properties of glass fiber composites. Carbonaceous nanomaterials such as CNTs and CNFs are the most common and the most promising additives used to fabricate multifunctional glass textile nanocomposites with enhanced capabilities.In this study, the ability of CNFs to improve electrical conductivity and alter the mechanical properties of epoxy nanocomposites is investigated. The conductive CNFs/epoxy nanocomposite is then used to monitor damage propagation in glass textile-reinforced polymer composites under static loading.

METHODOLOGY:

Nanofibres:

Normally nanofibres are produced by electrospinning process. A basic electrospinning system consists of a charged polymer solution that is fed through a small opening or nozzle (usually a needle or pipette tip). Because ofits charge, the solution is drawn toward a grounded collecting plate (usually a metal screen, plate, or rotating mandrel), typically 5-30 cm away, as a jet. During the jet's travel, the solvent gradually evaporates, and a charged polymer fiber is left to accumulate on the grounded target. The charge on the fibres eventually dissipates into the surrounding environment. The resulting product is a nonwoven fiber mat that is composed of tiny fibres with diameters between 50 nanometres and 10 microns. Potential uses for electro-spun fibres are in filtration, wound dressings, tissue engineering, nanocomposites, drug delivery devices and sensors. Shows nanofibres electrospun onto a polyester spun- bonded substrate; the substrate was chosen to provide the required mechanical, whilst the nanofibre web dominates filtration performance. Shows commercially-available nanofibres (fibre diameter approximately 250 nm) electrospun onto a cellulose substrate for air- filtration applications.

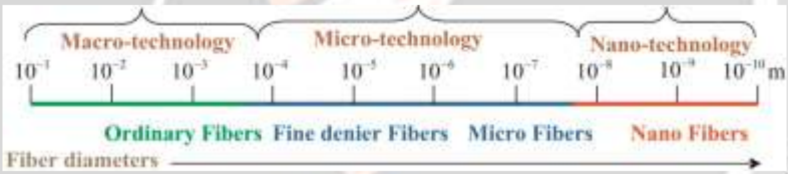

Figure1: Length Of Nanofibre

Materials and Fabrication:

CNFs were supplied by Nanostructured & Amorphous Materials Inc. They had diameter of 80–200 nm and a length of 0.5-20 µm and thus an aspect ratio ranging between 6.3 and 100.The performance of the CNFs-polymer nanocomposite is affected by the homogeneity of nanofibers dispersion into the polymer matrix. CNFs with different contents (0, 0.3, 0.5, 1.0, 1.5, 2.0 and 2.5 wt %) were first hand-

stirred into the epoxy resin, and then sonicated in a path sonicator for 1 h at 40 °C and frequency of 40 kHz. The resin- CNFs mixture was further dispersed using a high shear mixer atspeed 11,000 rpm at a temperature of 90 °C for 1 h. The resin-CNFs mixture was then mechanically stirred at temperature of 90 °C for 2 h and a speed of 800 rpm. The resin- CNFs mixture was degassed to remove the bubbles for 30 min at 50 °C and then left to cool for 1 h at room temperature. After cooling, the epoxy hardener was hand-stirred into the resin-CNFs mixture for 5 min and left overnight. CNFs/ epoxy nanocomposite was then cured for 2.5 days at 110 °C to ensure full curing.

To prepare glass fiber reinforced (GFRP) composites, after adding the epoxy hardener to the resin-CNFs mixture, that mixture was then used to fabricate the GFRP using the hand layup technique. Six layers of bidirectional plain weave glass fiber textile fabrics were laid in 0° direction, and then vacuum pressure was applied for 24 h. The glass fiber composite plates were then cured for 2.5 days at 110 °C to insure complete curing. 2 wt % CNFs were used to fabricate glass fiber composites. The CNFs content used for producing the glass fiber composites was based on the electrical percolation observations of epoxy-CNFs nanocomposites are discussed. Fiber volume fraction of glass fiber composites incorporating 2.0 wt % CNFs was determined using ASTM D3171 and was found to be 55.6%. To examine the

dispersion of CNFs in the epoxy matrix, fractured surfaces of the epoxy-CNFs nanocomposites were covered with a layer of gold and were then investigated using the Field Emission Scanning Electron Microscope (FESEM)

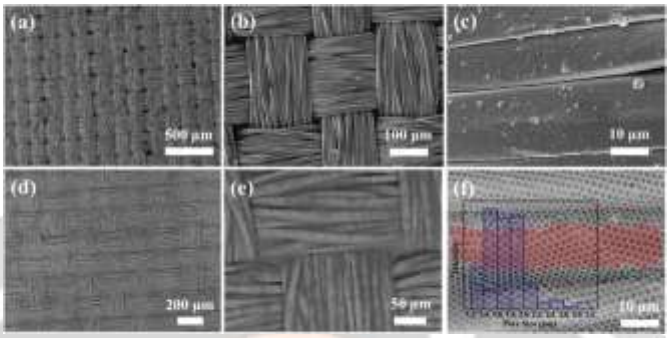

Figure 2: Microscopic image

ANTIBACTERIAL PROPERTIES

Considering the special advantages of the application of nanostructured materials in textile industry, this section is focused on the modification of textile surface using different kinds of nanostructured materials which show excellent antimicrobial properties. Among all metallic materials, silver is of particular interest because it is a powerful antibacterial agent, showing antimicrobial efficacy against bacteria, viruses, and microorganisms. This excellent antibacterial activity makes possible their use in different and varied fields suchas food preservation,
safe.
nanoparticles

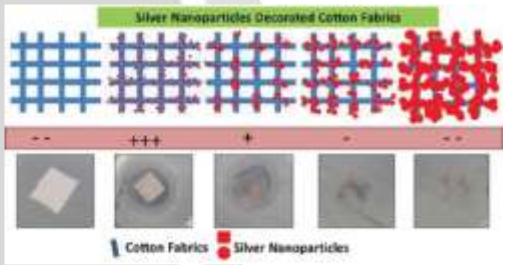

Figure 3: Silver

cosmetics, medical devices,water treatment , or textiles fabrics. An important aspect is that silver in both ionic and colloidal forms shows low toxicity to human cells and high biocompatibility. However, the real mechanism of antimicrobial action related to the silver is not well understood, and different hypotheses are considered by the scientific community. Several studies indicate that the antibacterial effect is due to the release of silver ions from silver nanoparticles (Ag NPs), whereas other approaches are devoted to the adverse effect of the Ag NPs in the cell membrane, being these Ag NPs the responsible of the cell death

IMPROVEMENTS IN FIBRE/ YARN MANUFACTURING BY USING NANOTECHNOLOGY

The properties and performance of textile fibers are essential to fabric manufacturing and utilization. While it is well- known that fabrics made of cotton fibers provide desirable properties, such as high absorbency, breathability, and softness for wear and comfort, expanded utility of cotton fabrics in certain classical and especially non-classical applications is somewhat limited due to the fiber’s relatively low strength, less-than-satisfactory durability, easy creasing, easy soiling, and flammability. On the other hand, fabrics made with synthetic fibers generally are strong, crease resistant, antimicrobial, and dirt resistant. However, they certainly lack the comfort properties of cotton fabrics. A wide range of fiber size or thickness can be utilized in textile processing.Ordinary and fine-denier textile fibers range from 1 to 100 µm in diameter and are produced by established dry- wet-dry, jet melt spinning through spinnerets 1–100 µm in diameter. Nano-fibers of diameters in the nanometer range are mostly manufactured by electro-spinning process, although there are also other methods. Carbon nanotubes (CNT) provide fibers of ultra-high strength and performance. It was shown that super-aligned arrays of CNT provide nano-yarns that exhibit Young's modulus in the TPa range, tensile strength equaled 200 GPa, elastic strain up to 5%, and breaking strain of 20%.

In electro- spinning, a charged polymer melt or solution is extruded through sub-micrometer diameter spinnerets to afford fibers on a grounded collector plate subjected to high potential difference between the spinnerets and the plate. The process is an established technique to generate fibers of extremely small diameters and enhanced properties. Further enhancement of fiber strength and conductivity is achieved with heat treatment. The resulting nano-fibers find applications such as bullet-proof vests and electro-magnetic wave-tolerant fabrics. However, it should be mentioned that mechanical properties of textiles reinforced by CNT do not necessarily meet the very high levels of properties of constituent nano-fibers.The growing applications of nanotechnologies in special-purpose, textile, and related composites certainly have advantages of transverse surface

It was discovered that unique composite fibers were produced from synthetic nano-fibers obtained through an advanced electro-spinning process, such as the coagulation-based carbon-nano-tube spinning method. These composite fibers afford electronic textiles for super capacitors. During electro-spinning process, nano-yarns, comprised of Multi-Walled CNT (MWCNT) that consist of several (usually 7 to 20) concentric cylinders of Single- Walled CNT, can be produced by simultaneous reduction of fiber diameter and increase in twist (up to 1000 times) in the electro-spinning process. These highly twisted yarns facilitate extra strength, toughness, energy-damping capa- bility, etc., and thus can be deployed to produce electronic textiles for supporting multi-functionalities, such as capability for actuation, energy storage capacity, radio or microwave absorption, electrostatic discharge protection, textile heating, or wiring for electronic devices. It is clear that the current developments in nano-fibers and nano-yarns will be utilized in producing the next generation textiles, which would be capable of providing radio or microwave absorption, electrostatic discharge protection, textile heating, or wiring for electronic devices.

By changing the surface structures of synthetic fibers, several diverse fiber functionalities can be obtained for profitable exploitation of functional fabrics in special applications. One of the possibilities to develop desired functionality is by embossing the surface of synthetic fibers

with nano-structures. Integration of nano-sized antimi- crobial particles into textile fibers leads to the development of superior wound dressings. Similarly, by incorporating ceramic nano-particles into a spinning solution, polyimidoa- mide fibers can be produced in which SiO_2 nano-particles are present. Such a "nano-treatment" can also produce anti- static polyacrylonitrile (PAN) fibers consistis of electrically conductive channels, which not only possess antistatic properties but also have good mechanical properties.

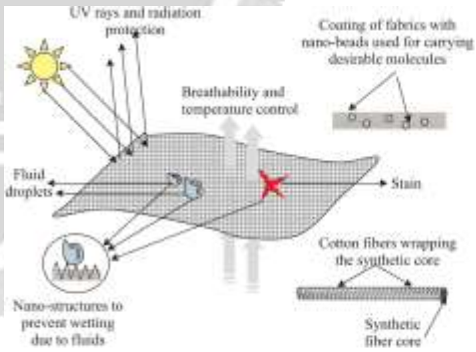

Figure 4: Properties of Nanofibres

Chemical modifications of synthetic fibers using nano-particles can enhance the fibers' porosity and absorption properties, which are useful in producingthermal-resistant and flame-resistant fabrics. Desirable thermal properties as well as enhanced fiber tenacity can also be obtained by modifying the surface of the fibers with other (nano-) matters, such as diamine (diaminodiphenyl methane), montmorillo- nite, and silica nano-particles, etc. Specific functionality in fibers can also be achieved by another leading chemical oxidative deposition technology, which deals with the deposition of Conducting Electroactive Polymers (CEP), that is, polyaniline, polypyrrole, polythiophene, and their derivatives (in nano-form) onto different kinds of synthetic fibers, resulting in special composite fibers with high tensile strength and good thermal stability.

Surface polymerization of CEP (by Graft copolymerization) of polymer fibers has a potential to increase the fibers' conductivity almost 10 times by decreasing their electrical resistivity. These so-called coated polymeric composite fibers can be used in microwave attenuation, EMI shielding, and dissipation of static electric charge. They can also be useful in developing fabrics intended for military applications, for example., camouflage, stealth protection, The development of nano- composites usually containing 2 to 5% of nano-fibers has been extensively reviewed by Mondal. The basic properties, fabrication process, and some applications of nano-fibers or nano- tubes are covered. Some "nano- mechanical" properties of transverse sections of mature and immature cotton fibers have also been investigated and the behavior, properties, and potential applications of thesetextile micro structures.

Figure 5: Materials Used

By uniformly dispersing aligned nano-tubes in the polymer matrix,some novel CNT reinforced polymer composite materials have been developed, which can be used for developing.

multifunctional textiles having superior strength, toughness, lightweight, and high electrical conductivity. By using melt- spinning process, polypropylene/ nano-carbon fiber composites with significantly enhanced modulus, compressive strength, and dispersion properties can be produced. The morphology, crystallinity, and several mechanical properties of non-woven mats containing nano-structured poly-capro-lactone (PCL). Through optimal orientation and crystallization of nano-fibers, excellentproperties of composite fibers can be achieved and successfully used for the micro- filtration applications in the medical field.

CONCLUSION

Nanoparticles are a new promising kind of materials for functionalization of fibers and textiles. There are numerous significant scientific research works that report their suitability for high-value functional textile applications. The addition of nanoparticles to traditional synthetic fibers is usually performed using well-known techniques such as pad- dry-cure processes. Other techniques such as corona treatments and in situ synthesis of the nanoparticles have been successfully used as alternative functionalization techniques with very good results. The antibacterial functionality is the most demanded application for nanoparticles into textile fibers.It is extremely difficult and complex to process carbon fibers of< 200 nm with traditional textile practices and procedures the nanotechnology field is still a developing area with several challenges as well as prospects, unsolved difficulties, and commercial opportunities. Our exposure to nanoparticles from textile materials is developing.Nanomaterials are present in certain commercial products, some of which are not labelled while some are labelled, and there will certainly be more to establish. Therefore, it is significant that the textile industries have adequate knowledge about nanomaterials so as to make safe choices.It was also observed that a significant improvement in the electrical conductivity of CNFs/epoxy nanocomposite is achieved with a percolation threshold equal to 1.5 wt %. It is evident that using CNFs during fabrication of GFRP composites allows damage initiation and damage propagation in GFRP to be monitored with acceptable repeatability and resolution.We can summarize that nanotechnology research in textiles and fibres has a lot of potentials as a future scope of approach but would be largely goverened by simultaneous progress in the newer, faster, simpler and more efficient techniques for nano materials, nanocoatings and nanocomposites are used in fibre and textiles.

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