A Review – Nano Technology in Textile composites

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Abstract

Textile composites industry getting steady response from the users, this is not only replacing the conventional use of textile materials but also comprises the use of natural bast fibres and allied industry waste. Nanotechnology is a vast and growing field which adds value to textile composites. Nano composites research and the massive benefits it promises have attracted considerable press coverage over the past decade. Initially the composites developed for a robust manufacturing technology which determine to produce high-value, low-cost materials, under reasonable conditions. The nanotechnology composites used for number of applications such as Electronics applications, electromagnetic interference shielding or lightning strike protection, medical textiles etc.

Keywords - Composites, Nano composites, Nanotechnology, Medical Textiles.

Introduction

Over the last thirty years composite materials, plastics and ceramics have been the dominant emerging materials. The volume and number of applications of composite materials have grown steadily, penetrating and conquering new markets relentlessly. Modern composite materials constitute a significant proportion of the engineered materials market ranging from everyday products to sophisticated niche applications. While composites have already proven their worth as weight-saving materials, the current challenge is to make them cost effective. The efforts to produce economically attractive composite components have resulted in several innovative manufacturing techniques currently being used in the composites industry. Nanotechnology is an emerging field through which new productions on large scale can be manufactured. Producing a new generation of textiles which enjoy antimicrobial properties using nanoparticles has attracted a great deal of attention on the part of both scientists and consumers in recent years. Furthermore, metal nanoparticles show unique properties due to their peculiar electronic configuration, very large surface area and high amount of surface atoms. For instance, the metal nanoparticles show a board absorption band in the visible region of the electromagnetic spectrum. Some amazing properties of metals are used in order to improve the photo catalytic activities of semiconductors such as TiO_2, SiO_2, which are among the most efficient ones resulting in higher photo catalytic properties even under visible rays. Some noble metals such as Ag, Au, and Pd have stood the test of time in the field of producing Nano composites. Nano silver which is one of the outstanding nanomaterial among noble metals has wide applications in distinctive industries such as medicine, biochemistry, electrochemistry, and optic and indeed its consumption in textile industry due to obtaining antimicrobial properties.

It has been established that nanoparticles have unique chemical, electrical, optical, and physical properties and biological activity that may differ significantly from ion and bulk materials and that these properties are mainly determined by the size, shape, composition, crystallinity and structure of the nanoparticles. The route of synthesis of metal nanoparticles has a major influence on their size, shape and morphology. As conventional non-material synthesis involves the use of hazardous chemicals, low material conversions, high energy requirements and wasteful purification, most novel production methods are focused on "green synthesis," including the use of non-toxic chemicals, environmentally benign solvents and renewable materials. It is believed that the antimicrobial activity of metal nanoparticles arises from both their small particle size and high specific surface area.

Textile composites

"Composites are multifunctional material systems that provide characteristics not obtainable from any discrete material. They are cohesive structures made by physically combining two or more compatible materials, different in composition and characteristics and sometimes in form. For the sake of simplicity, however, composites can be grouped into categories based on the nature of the matrix each type possesses. Methods of fabrication also vary according to Physical and chemical properties of the matrices and reinforcing fibers.

Polymer Matrix Composites (PMCs)

The most common advanced composites are polymer matrix composites. These composites consist of a polymer thermoplastic or thermosetting reinforced by fiber (natural carbon or boron). These materials can be fashioned into a variety of shapes and sizes. They provide great strength and stiffness along with resistance to corrosion. The reason for these being most common is their low cost, high strength and simple manufacturing principles.

Metal Matrix Composites (MMCs)

Metal matrix composites, as the name implies, have a metal matrix. Examples of matrices in such composites include aluminium, magnesium and titanium. The typical fiber includes carbon and silicon carbide. Metals are mainly reinforced to suit the needs of design. For example, the elastic stiffness and strength of metals can be increased, while large co-efficient of thermal expansion, and thermal and electrical conductivities of metals can be reduced by the addition of fibers such as silicon carbide.

Ceramic Matrix Composites (CMCs)
Ceramic matrix composites have ceramic matrix such as alumina, calcium, aluminosilicate reinforced by silicon carbide. The advantages of CMC include high strength, hardness, high service temperature limits for ceramics, chemical inertness and low density. Naturally resistant to high temperature, ceramic materials have a tendency to become brittle and to fracture. Composites successfully made with ceramic matrices are reinforced with silicon carbide fibers. These composites offer the same high temperature tolerance of super alloys but without such a high density. The brittle nature of ceramics makes composite fabrication difficult. Usually most CMC production procedures involve starting materials in powder form. There are four classes of ceramics matrices: glass (easy to fabricate because of low softening temperatures, include borosilicate and alumina silicates), conventional ceramics (silicon carbide, silicon nitride, aluminum oxide and zirconium oxide are fully crystalline), cement and concreted carbon components.

Carbon-carbon composites (CCMs)
CCMs use carbon fibers in a carbon matrix. Carbon-carbon composites are used in very high temperature environments of up to 6000 of, and are twenty times stronger and thirty times lighter than graphite fibers.

Nano technology
Nanotechnology involves the creation and manipulation of particles at the nanoscale, that is, particles that range in size from 1 to 1,000 nanometers (nm), where 1 nm equals 1 billionth of a meter. Nanomaterial include single-wall carbon nanotubes (CNTs), which are long, thin cylinders of carbon atoms arranged in a graphitic lattice structure, and multiwall carbon nanotubes, which are concentric cylinders of carbon atoms in a similar graphite structure held together by weak intermolecular forces. These carbon-based particles have aspect ratios that range from 100:1 to 10,000:1.

Making of Composites:
Composites are hybrid materials made of a polymer resin reinforced by fibres, combining the high mechanical and physical performance of the fibres and the appearance, bonding and physical properties of polymers. Making of composites generally makes use of two materials which are as follow:

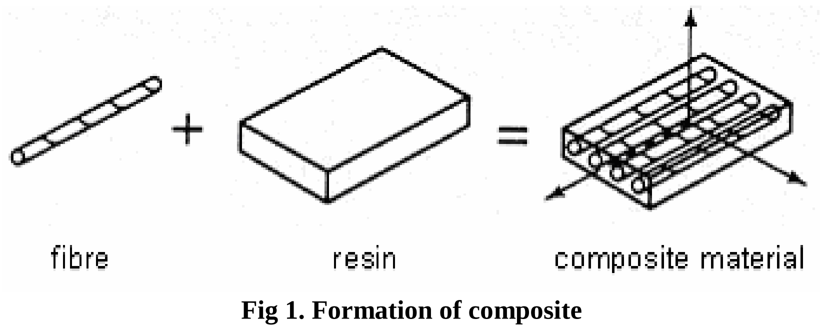

Fig 1. Formation of composite

Composite composition
The short and discontinuous fibre composites are responsible for the biggest share of successful applications, whether measured by number of parts or quantity of material used. The most important part in composites is that they are tailor made products i.e. their physical and mechanical properties can be molded according to the need of user. Therefore different layers of fibres are sandwiched together to obtain the composite material. As shown in the figure below we can observe that how fibres placed in different directions on combining together overcome the strength problems which they faced in individual stage.

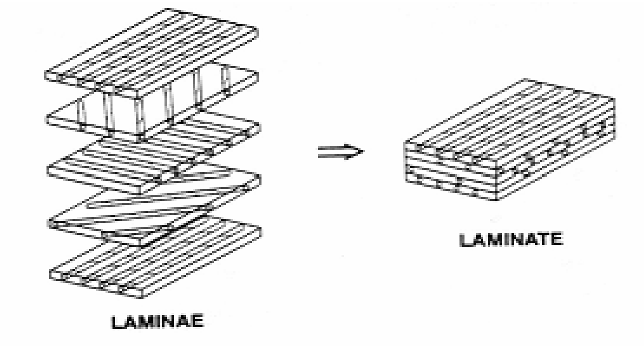

Fig2. Formation of composite composition

Tailored composites

The composite makes use of number of techniques for their manufacturing but the most Commonly used manufacturing processes are as follow:

1. Hand laminating
2. Resin injection technique
3. Hot pressure method
4. Filament winding Pultrusion

Characteristics of the Composites

A composite material consists of two phases. It consists of one or more discontinuous phases embedded in a continuous phase. The discontinuous phase is usually harder and stronger than the continuous phase and is called the ‘reinforcement’ or ‘reinforcing material’, whereas the continuous phase is termed as the ‘matrix’. The matrix is usually more ductile and less hard. It holds the dispersed phase and shares a load with it. Matrix is composed of any of the three basic material type i.e. polymers, metals or ceramics. The matrix forms the bulk form or the part or product. The secondary phase embedded in the matrix is a discontinuous phase. It is usually harder and stronger than the continuous phase. It servers to strengthen the composites and improves the overall mechanical properties of the matrix. Properties of composites are strongly dependent on the properties of their constituent materials, their distribution and the interaction among them. The composite properties may be the volume fraction sum of the properties of the constituents or the constituents may interact in a synergistic way resulting in improved or better properties. Apart from the nature of the constituent materials, the geometry of the reinforcement (shape, size and size distribution) influences the properties of the composite to a great extent. The concentration distribution and orientation of the reinforcement also affect the properties. The shape of the discontinuous phase (which may by spherical, cylindrical, or rectangular cross-sanctioned prisms or platelets), the size and size distribution (which controls the texture of the material) and volume fraction determine the interfacial area, which plays an important role in determining the extent of the interaction between the reinforcement and the matrix.

Concentration, usually measured as volume or weight fraction, determines the contribution of a single constituent to the overall properties of the composites. It is not only the single most important parameter influencing the properties of the composites, but also an easily controllable manufacturing variable used to alter its properties.

Applications of Nano technology in Textile composites

1. ***Nano composite Plastics and Carbon Nanotubes in Packaging***
2. ***Nano porous Compounds in Insulation and Microelectronics***
3. ***Nanoparticles in Plastic and Colloids***
4. ***Nano Coatings***
5. ***Smart Textiles.***
6. Nano encapsulation in composites for fragrance finishing.
7. Nano compounds for making of Non-woven composites.

Conclusion:

Today there is emerging trend in composites and many of the products have gain importance by merging with another product. It has been found that composites have already proven their worth as weight-saving materials; the current challenge is to make them cost effective. The efforts to produce economically attractive composite components have resulted in several innovative manufacturing techniques which are presently being used in the composites industry. Nanotechnology is an emerging field through which new productions on large scale can be manufactured.

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