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Nanocomposites and Its Applications

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***Abstract*— Nanocomposite is a multiphase solid material where one of the phases has one, two or three dimensions of less than 100 nanometers.**

Keywords— Multiphase material - one dimension - less than100 nm

Introduction

Nanocomposites are materials that are composed of two or more constituents,with different physical and chemical properties, which remain separate and dis-tinct at the microscopic level but collectively comprise a single physical material possessing any phase dimension of less than 100 nm [1–3]. In the broadest sense, the primary motivation of making a nanocomposite is to integrate one or more discontinuous nano-dimensional phases into a single continuous macrophage to generate "synergistic properties;" that is, the physical/chemical properties of the combined entity are inherently different from, and hopefully superior to, those of the individual material constituents. In this

. Based on the different types of matrix materials,nanocomposites can be generally divided into four categoriesincluding polymer-, carbon-, metal-, and ceramic-based nanocomposites. Polymers are large molecules or macro molecules composed of repeating structural units, typicallyconnected by covalent chemical bonds; these are generally excellent host matrixes for nanocomposite materials due totheir light weight, ease of processing, low-cost manufacturing, and good adhesion to substrates [4, 5].Polymer nanocom-posites (PNCs) are polymer compositesusing nanostructured materials as reinforcements. Dependingon the type of reinforcement material, different properties can be achieved for PNCs.

A. Nanocomposites Concept

Nanocomposites are materials that have a solid structure

context, one of the combined material's constituents is generally in much greater concentration and forms a continuous "matrix" surrounding the others, which assume the role of a "nanofiller" or "reinforcement." During the nanocomposite formation process, each of the distinct phases is structure- and property-integrated to fabricate hybrid materials that possess multifunctionalities in terms of both structures and material properties. As scientific and societal needs in the late twentieth

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century drove the demand for higher-performance, sustainable, and multifunctional nanomaterials, more innovative nanotechnology and nanocomposites were increasingly investigated. The advent of new materials and characterization tools in the nanotechnology domain has been paving the way for the latest design of

next-generation nanocomposites that not only are easily controllable but also possess multiple intrinsic engineering functionalities

inorganic matrix set in the organic phase, or vice versa, froman organic matrix set in the inorganic

B. Nanocomposites Applications

Food packagingBio sensor Energy saving Textile Weapons Transportation

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II. Food Packaging

The basic need of packaging is to protect the different types of food items from any kind of physical, chemical, and biological damage. The food products include fruits, vegetables, milk and milk products, meat, dry fruits, bakery products, and sauces require more emphasis on the shelf life and nutrition quality [12]. In this context, various methods of packaging and materials are used depending on the kind of products packed. The food packaging operations are carried out to encounter several objectives such as physical protection, transportation, marketing, information transmission, anticounterfeiting, and anti tampering. Moreover, to protect different kinds of processed and unprocessed food items, a different material and design is required. Also, it serves as a way of increasing revenue of the product company; the more attractive the packaging, the more it sells. The company Paper Boat beverage packaging design is unique and flexible with attractive shape and color as well as durable and easily carryable packaging for their juices (Paper Boat Packaging: Unique Flexible Packaging for Beverages (bizongo.com). As per a report submitted by Market Research Future (MRFR), Food Packaging Market is projected to be worth USD 466.91 billion by 2027, registering a CAGR of 6.17% during the forecast period (2021-2027). The market was valued at USD 310.8 billion in 2020 (Market Research Future-Industry Analysis Report, Business Consulting and Research).

A. Bio Sensors

Nanomaterials are generally used as transducer materials that are an important part for biosensor development. A biosensor consists of four parts namely (1) bioreceptor, (2) a transducer, (3) a signal processor for converting electronic signal to a desired signal, and (4) an interface to display. A variety of samples such as body fluids, food samples, and cells culture can be explored to analyze using biosensors.

The engineered nanomaterials provide higher electrical conductivity, have nanoscale size, can be used to amplify desired signals, and are compatible with biological molecules [7]. For example, carbon materials can be utilized for conjugation of biomolecules (enzyme, antibody, DNA, cell, etc.). It has been found that the use of nanomaterials may lead to increased biosensor performance including increased sensitivities and low limit-of-detection of several orders of magnitudes. Nanostructured materials show increased surface-to-volume ratio, chemical activity, mechanical strength, electrocatalytic properties, and enhanced diffusivity. Nanomaterials have been predicted to play an important role toward the high performance of a biosensor. To probe biomolecules such as bacteria, viruses, DNA, etc. Biocompatibility of nanomaterials is an important factor for designing a biosensor. Nanomaterials with various applications for biosensor development are discussed in this chapter.

An important challenge is the standardization of immobilization procedures that can be utilized to intimately conjugate a biomolecule onto a nanomaterial. Therefore, the technique used to immobilize a given enzyme is one of the key factors in developing a reliable biosensor. A nanomatrix can be an excellent candidate to immobilize biomolecules on a transducer surface that can efficiently maintain bioactivity of the biomolecules. There are still many challenges such as miniaturization, automation, and integration of the nanostructured-based biosensors. Define abbreviations and acronyms the first time they are used in the text, even after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, sc, dc, and rms do not have to be defined. Do not use abbreviations in the title or heads unless they are unavoidable.

ENERGY SAVING:

To meet the rising need for on-demand electric energy, dielectric capacitors have been of increasing interest owing to their unique energy storage properties. The ability to deliver large amounts of energy instantaneously with a simple device that can last over millions of cycles is making dielectric capacitors one of the most attractive future options for large-scale electrical energy storage. The low gravimetric energy density, however, has prevented its widespread application in a wide range of fields including electric vehicles, and personal power technologies. Ceramic and polymer materials are being developed for energy storage, however, intrinsic limits on their dielectric properties (e.g., breakdown field and dielectric constant, respectively) prevents them from being used for high energy density applications. Because of this, composite systems of ceramics and polymers have been of increasing interest as they hold the potential for simultaneous improvement of both the dielectric constant and breakdown field leading to significant improvements in the energy storage potential. Herein we present new results and discuss the state of dielectric capacitor research including a discussion of the properties of interest. Recent developments in the field will be discussed including improvements in material properties, processing, and interface issues that arise when compositing materials as well as solutions to overcome these obstacles.

Energy saving:

Nanotechnologies promise revolutionary technologicalchanges for a wide range of military applications and platforms. Technologies to be incorporated within the platforms which are directly relevant to the defense arena include aerodynamics, mobility, stealth, sensing, power generation and management, smart structures and materials,resilience and robustness, etc. In addition, nanotechnologieswill have impact on battlespace systems concerned with information and signal processing, autonomy an intelligence .With regard to information technology, in particular, substantial advantages are expected to be gained from these1. Nanotechnology is a growing interdisciplinary technology

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new enabling capabilities which include threat detection,novel electronic displays and interface systems, as well as a pivotal role for the development of miniaturized unmanned autonomous vehicles (UAVs) and robotics. Nanotechnologywill enable the development of novel materials providing thebasis for the design and development of new properties and structures which will result in increased performance (e.g., nano-energetics and new types of catalysts), reduced cost ofmaintenance (e.g., wear reduction, self-healing and self repair), enhanced functionality (eg adaptive materials) and new types of electronic/opto-electronic/magnetic materialproperties.

Nanocomposites in weapons:

Nanotechnologies promise revolutionary technological changes for a wide range of military applications and platforms. Technologies to be incorporated within the platforms which are directly relevant to the defense arena include aerodynamics, mobility, stealth, sensing, power generation and management, smart structures and materials, resilience and robustness, etc. In addition, nanotechnologies will have impact on battlespace systems concerned with information and signal processing, autonomy and intelligence.With regard to information technology, in particular, substantial advantages are expected to be gained from these new enabling capabilities which include threat detection, novel electronic displays and interface systems, as well as a pivotal role for the development of miniaturized unmanned autonomous vehicles (UAVs) and robotics. Nanotechnology will enable the development of novel materials providing the basis for the design and development of new properties and structures which will result in increased performance (e.g., nano-energetics and new types of catalysts), reduced cost of maintenance (e.g., wear reduction, self-healing and self-repair), enhanced functionality (eg adaptive materials) and new types of electronic/opto-electronic/magnetic material properties.

Nanocomposites in textile:F2F

Search Textile Textile Apparel Fashion Retail ECommerce Technology

Sustainability

Analyst CornerEditor's Pick

Application of Nanotechnology in Textile Industry Application of Nanotechnology in Textile Industry

Nanotechnology in Textile:often seen as a new industrial revolution. Nanotechnology (NT) deals with materials 1 to 100 nm in length. The fundamentals of nanotechnology lie in the fact that the properties of materials drastically change when their dimensions are reduced to nanometer Now a days also the textile industry has discovered the possibilities of nanotechnology. So, we can define nanotechnology in textile as the understanding, manipulation, and control of matter at the above-stated length ,such that the physical, chemical, and biological properties of the materials(individual atoms, molecules, and bulk matter) can be engineered, synthesized, and altered to develop the next generation of improved materials, devices ,structures, and systems. It is used to develop desired textile characteristics ,such as high tensile strength, unique surface structure, soft hand, durability, water repellency, fire retardancy, antimicrobial properties, and the like.

Modern of Nanotechnology in Textile Industry:

Nanotechnology Is increasingly attracting worldwide attention because it is widely perceived as offering huge potential in a wide range of end uses. The unique and new properties of nanomaterials have attracted not only scientists and researchers but also businesses, due to their huge economic potential.

Nanotechnology has real commercial potential for the textile industry. This is mainly due to the fact that conventional methods used to impart different properties to fabrics often do not lead to permanent effects, and will lose their functions after laundering or wearing. Nanotechnology can provide high durability for fabrics, because nano particles have a large surface area-to-volume ratio and high surface energy, thus presenting better affinity for fabrics and leading to an increase in durability of the function. In addition, a coating of nano-particles on fabrics will not affect their breath ability or hand feel.

Application of Nanotechnology we can explain in threeways:

Application in department wise

Application in properties of textile material.Application in apparel industry.

Nanocomposites in transportation:

Nanotechnology has received increasing attention and is being applied in the transportation vehicle field. With their unique physical and chemical characteristics, nanomaterialscan significantly enhance the safety and durability of transportation vehicles. This paper reviews the state-of-the art of nanotechnology and how this technology can beapplied in improving the comfort, safety, and speed of transportation vehicles. Moreover, this paper systematicallyexamines the recent developments and applications ofnanotechnology in the transportation vehicle industry,including nano-coatings, nano filters, carbon black for tires, nanoparticles for engine performance enchantment and fuel consumption reduction. Also, it introduces the mainchallenges for broader applications, such as environmental,health and safety concerns. Since several nanomaterials haveshown tremendous performance and have been theoretically researched, they can be potential candidates for applications in future environmentally friendly transportation vehicles. This paper will contribute to further sustainable research and greater potential applications of environmentally friendly nanomaterials in healthier transportation vehicles to improve the transportation industry around the globe.

Conclusion

Nanocomposite hydrogels show potential to be used in a variety of different biomedical applications such as tissue engineering, therapeutic delivery, stem cell modulation and medical devices. These different biomedical and biotechnological applications are possible due to the tunable nature of the nanocomposite hydrogels. The improved properties of the nanocomposite hydrogels are mainly attributed to enhanced interactions between the polymer chains and the nanomaterials. Next generation of nanocomposite hydrogels will not only enhance mechanical and physical properties but will be able to deliver special bioactive cues which would make them more responsive and adaptable to the environment in which they would be utilized.

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