NANOCOMPOSITE & THEIR APPLICATIONS

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Abstract:

The world is on the brink of a new technological revolution beyond any human experience. Over the past decade, nonmaterial have been the subject of enormous interest. These materials, notable for their extremely small feature size, have the potential for wide-ranging industrial, biomedical, and electronic applications A nanocomposite is a multiphase solid material where one of the phases has one, two or three dimensions of less than 100 nanometers (nm), or structures having nano-scale repeat distances between the different phases that make up the material.[1] In the broadest sense this definition can include porous media, colloids, gels and copolymers, but is more usually taken to mean the solid combination of a bulk matrix and nano-dimensional phase(s) differing in properties due to dissimilarities in structure and chemistry. The mechanical, electrical, thermal, optical, electrochemical, catalytic properties of the nanocomposite will differ markedly from that of the component materials. Size limits for these effects have been proposed,[2] <5 nm for catalytic activity, <20 nm for making a hard magnetic material soft, <50 nm for refractive index changes, and <100 nm for achieving superparamagnetism, mechanical strengthening or restricting matrix dislocation movement

Keyword: Nano-scale, Nanopaticles, Nanotube

Introduction:

A nanocomposite is a multiphase solid material where one of the phases has one, two or three dimensions of less than 100 nanometers (nm), or structures having nano-scale repeat distances between the different phases that make up the material.[1] In the broadest sense this definition can include porous media, colloids, gels and copolymers, but is more usually taken to mean the solid combination of a bulk matrix and nano-dimensional phase(s) differing in properties due to dissimilarities in structure and chemistry.

Nan composites are found in nature, for example in the structure of the abalone shell and bone. From the mid-1950s nanoscale organo-clays have been used to control flow of polymer solutions (e.g. as paint viscosifiers) or the constitution of gels (e.g. as a thickening substance in cosmetics, keeping the preparations in homogeneous form). By the 1970s polymer/clay composites were the topic of textbooks,[4] although the term "nanocomposites" was not in common use

Production Processes:

To fabricate the nanocomposities the following production process are established.

(i) Standard Polymer production processes

(ii) Sol-gel

(iii) Coating techniques

(iv) Printing/imaging

Types of nanocomposities:

Ceramic-matrix nanocomposites

In this group of composites the main part of the volume is occupied by a ceramic, i.e. a chemical compound from the group of oxides, nitrides, borides, silicides etc.. In most cases, ceramic-matrix nanocomposites encompass a metal as the second component. Ideally both components, the metallic one and the ceramic one, are finely dispersed in each other in order to elicit the particular nanoscopic properties. Nanocomposite from these combinations were demonstrated in improving their optical, electrical and magnetic properties [5] as well as tribological, corrosion-resistance and other protective properties.[2]

Metal-matrix nanocomposites

Metal matrix nanocomposites can also be defined as reinforced metal matrix composites. This type of composites can be classified as continuous and non-continuous reinforced materials. One of the more important nanocomposites is Carbon nanotube metal matrix composites, which is an emerging new material that is being developed to take advantage of the high tensile strength and electrical conductivity of carbon nanotube materials. Critical to the realization of CNT-MMC possessing optimal properties in these areas are the development of synthetic techniques that are (a) economically producible, (b) provide for a homogeneous dispersion of nanotubes in the metallic matrix, and (c) lead to strong interfacial adhesion between the metallic matrix and the carbon nanotubes. In addition to carbon nanotube metal matrix composites, boron nitride reinforced metal matrix composites and carbon nitride metal matrix composites are the new research areas on metal matrix nanocomposites.[2]

Another kind of nanocomposite is the energetic nanocomposite, generally as a hybrid sol–gel with a silica base, which, when combined with metal oxides and nano-scale aluminum powder, can form *superthermite* materials

Polymer-matrix nanocomposites

In the simplest case, appropriately adding nanoparticulates to a polymer matrix can enhance its performance, often dramatically, by simply capitalizing on the nature and properties of the nanoscale filler [13] (these materials are better described by the term *nanofilled polymer composites* [13]). This strategy is particularly effective in yielding high performance composites, when good dispersion of the filler is achieved and the properties of the nanoscale filler are substantially different or better than those of the matrix. An example of this would be reinforcing a polymer matrix by much stiffer nanoparticles of ceramics, clays, or carbon nanotubes. It should be noted that the improvement in mechanical properties may not be limited to stiffness or strength. Time-dependent properties could be improved by addition of the nanofillers.[16] Alternatively, the enhanced crystallization behavior under flow conditions [17] and other physical properties of high performance nanocomposites may be mainly due to the high aspect ratio and/or the high surface area of the fillers, since nanoparticulates have extremely high surface area to volume ratios when good dispersion is achieved. . Nanoparticle dispersibility in the polymer matrix is a key issue, which limits the appliciable particle volume fraction and there for also the multi-functionality of the composite material. Recent research on thin films (thickness <50 micrometer) made of polymer nanocomposites has resulted in a new and scalable synthesis technique, which allows the facile incorporation of greater nano-material quantities .[20] Such advances will enable the future development of multi-functional small scale devices (i.e. sensor, actuator, medical equipment), which rely on polymer nanocomposites(3,4)

A Survey of the applications of nanocomposites:

The following survey of nanocomposite applications introduces you to many of the uses being explored, including.

Producing batteries with greater power output. Researchers have developed a method to make anodes for lithium ion batteries from a composite formed with silicon nanospheres and carbon nanoparticles. The anodes made of the silicon- carbon nanocomposite make closer contact with the lithium electrolyte, which allows faster charging or discharging of power.

Speeding up the heaing process for broken bones. Researchers have shown that growth of replacement bone is speeded up when a nanotube-polymer nanocomposite is placed as a kind of scaffold which guides growth of replacement bone. The researchers are conducting studies to better understand how this nonocomposite increases bone growth.

Producing structural components with a high strength- to – weight ratio. For example an epoxy containing carbon nanotubes can be used to produce nanotube- polymer composite windmill blades. This result in a strong but lightweight blade, which makes longer windmill blades practical. These longer blades increase the amount of electricity generated by each windmill. (5)

Using grapheme to make composites with even higher strength – to – weight ratios. Researchers have found that adding grapheme to epoxy composites may result in stronger/ stiffer components than epoxy composites using a similar weight of carbon nanotubes. Grapheme appears to bond better to the polymers in the epoxy, allowing a more effective coupling of the grapheme into the structure of the composite. This property could result in the manufacture of components with higher strength – to – weight rations for such uses as windmill blades or aircraft components.(6)

Making lightw eight sensors with nanocomposites. A Polymer-nanotube nanocomposite conducts eledtrucity show well it conducts depends upon the spacing of the nanotubes. This property allows patches of polymer-nanotube nanocomposite to act as stress sensors on windmill blades. When strong wind gusts bend the blades the nanocomposite will also bend. Bending changes the nanocomposite sensor's electrical conductance. Causing an alarm to be sounded. This alarm would allow the windmill to be shut down before excessive damage occurs.

Using nanocomposites to make flexible batteries. A nanocomposite of cellulous materials and nanotubes could be used to make a conductive paper. When this conductive paper is soaked in an electrolyte, a flexible battery is formed.

Making tumors easier to see and remove. Researchers are attempting to join magnetic nanoparticles and fluorescent nanoparticles in nanocomposite particles that is both magnetic and fluorescent. The magnetic property of the nanocomposite particle makes the tumor more visible during an MRI procedure done prior to surgery. The fluorescent property of the nanocomposite particle could help the surgeon to better see the tumor while operating.

Conclusion

Nanocomposities promise new applications in many field such as mechanically reinforced lightweight components, nonlinear optics, batterycathodes&ionics nanowires, sensors&other system .Carbonnanotubes are used as reinforcing paticles in nanocomposities but also have many other potential applications. They could be the basis for a new era of electronics devices smaller &more potential than any previously envisiched. Nanocomputer based on carbon nanotubes have already been demonstrated. It is not so amazing, then that government bodies, Companies & university researchers are joining forces or competing to synthesize, investigate, produce&apply these amazing nonmaterial.

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