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Effect of Nanotechnology in Enhancing Mechanical Properties of Composite Materials

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Abstract

When two individual components with different physical and chemical properties are mixed together to make one component, it is known as a composite material. The two individual components are mixed together to give a unique properties. Nanotechnology ('Nanotech') is a manipulation of matter on super molecular, atomic and molecular scale. Nanotechnology as defined by size is naturally very broad, including fields of science as diverse as micro fabrications and organic chemistry etc. In this paper, we have discussed about the Nano-composites and Nano-technology using Nano fillers/ particles such as carbonized bagasse fibers, kenaf fibers, carbon Nano fibers coconut Nano sized filler, ZnO, silica, etc. in composites. The review shows that adding the above mentioned Nano additives enhancing mechanical properties of composite materials.

Introduction

Many of the composites are made of only two components. The biggest advantage of composites is that they are strong as well as light. The two individual components are mixed in which one is the binder and other is the matrix. It binds and surrounds together the fiber and fragments of different materials known as reinforcements. A new material can be made to fulfill the application needed. The new composites are also made with the carbon Nano tubes which Is also discussed in the paper In this paper when cement composite are mixed with bagasse fibers the composites becomes strong and increase in the mechanical and fracture toughness , polyester Nano composites fibers is added to zinc oxide (ZnO) loaded linear low density polyethylene (LLDPE) which increases the antibacterial properties, Poly (lactic acid) bio composites reinforced with kenaf fibers are made to increase in the flexure resistance and increase in the modulus ,UHMWPE/Nano epoxy bundle composites are also made to increase the viscosity and strength of the composites ,Carbon Nanofiber/phenylethyl terminated polyimide composite tends to increase in the tensile strength, Thermal behaviour of chemically treated sisal powder filled polyvinyl alcohol (PVA) bio composites which minimize the elongation values. Nano particle type effect on flexural, interfacial and vibration properties of GFRE composites which enhances the flexure strength and interfacial bonding. In Alumina and silica based epoxy Nano-composites for electrical insulation dielectric properties has been improved. As in Break down properties of low density polyethylene/ Nano-ZnO composites electric break down properties has been improved. And in Percolation and interfacial characteristics on breakdown behaviour of Nano-silica/Epoxy composites the breakdown strength of modified silica is improved. These factors have been discussed in the paper.

Cement composites with Nano bagasse fibers

Nano/micro carbonized particles produced with the help of waste bagasse fibers is used improve the mechanical properties and fracture pattern of composites. When it is added to cement paste in different proportions it increases the mechanical strength and also the fracture toughness. The observations like micro-cracking and crack pinning can also explain the increase in toughness of the composites. The bagasse fibers used in composite are sugarcane bagasse fiber. Sugarcane bagasse is a waste produced from sugar industries. The availability of sugarcane fiber is more so these fibers were used as reinforcing material in cementations composites. The cement used for the work is ordinary cement. The flexure strength and the fracture toughness have been increased due to Nano/micro modification. Due to some experiments of CMOD the modulus of rupture and fracture toughness has been evaluated. The results demonstrated that significant increase in the flexural strength and also fracture toughness of cement composites with the addition of CRBF (carbonized bagasse fibers). The crack pinning and the crack deflection were observed in the complicating the straight crack paths on the addition of CRBF (carbonized bagasse fibers) particles. In a relative straight direction through dense hydration products it shows a major crack in the plain cement paste. It has two major steps first, raw bagasse fibers were dispersed into water and then cement was mixed with solution. The specimen formed kept in plastic box partially filled with water for 24 hrs. The result demonstrated the improvement of flexural resistance

Polyester Nano composite fibers

When antibacterial Nano composite polyester fiber (PET) is added to zinc oxide (ZnO) and loaded linear low density polyethylene (LLDPE) were melt together to PET chips, the antibacterial Nano composite polyester fibers (PET) having 1% Nano ZnO showed maximum antibacterial properties. The mechanical properties are mostly affected by the crystallization temperature in the presence of Nanoparticle. The crystalline temperature in the presence of Nanoparticles from which the mechanical properties were also affected to the acceptable limit. When

the composite is compared with pure polyester the enhancement in mechanical, thermal, optical, and physicochemical properties was shown. In comparison to conventional materials Nano particles can give high durability for treated fibers, due to large surface area which give strength to fibers to increase in durability of textile function. Linear low density polyethylene (LLDPE) is very flexible with good elongation properties tensile resistance and good chemical resistance properties .When Nano composite polyester fiber(PET) are used with the antibacterial materials the resultant were used to reduce the disease transfer among the hospitals populations and also used for bio fare protection and other applications. And also many methods were used like formation of zinc oxalate melt spinning, dyeing of Nano composite fibers etc. In dyeing the spun filament were cut into the fine fibers then dyed using standard method of dyeing in high temperature of PET fibers. Then clearing treatment for 20 minutes took place. Evaluations of wash fastness, evaluation of light fastness are some more methods. In the curve of X-ray diffraction there are no peak due to impurities and the peak was unwind due to the particle size were very small hence the result shows the progressive increase in the antibacterial activity.

Poly lactic acid composites with graphite Nano platelets

The Nano composites are made by melting and also by mixing injection moulding after melting and mixing the kenaf fibers. For high rate manufacturing methods, simple, a low cost in a wide range of applications of PLA composites should be used. The composites have high viscosity due to poor dispersion and difficulty in processing of injection moulding and melt mixing the kenaf-PLA composites. Fibers were coated with graphite Nano platelets xGnp (graphite Nano fibers) using sonications the flexure modulus is enhanced by 25%-30%. At any fiber loading used, it will not increase the strength of the fiber also it indicate the less loading at the polymer xGnp or at the kenaf fibers xGnp finally, graphite Nano platelets (xGnp) is added hence for higher fiber loading it has positive effect on heat distortion temperature. The disposal is challenging because these composites are neither biodegradable nor come from renewable sources. The kenaf fibers are well dispersed with in PLA composites. In X ray diffraction the PLA peak becomes narrow due to the addition of kenaf fibers. The high loading kenaf fibers has to increase the mechanical properties of bio polymer such as PLA and the electrical/thermal conductivity of these material. The results was shown by flexural strength and modulus and the viscoelastic properties due to the synergy between the two reinforcement the flexure strength and modulus were significantly enhanced.

UHMWPE/Nano epoxy bundle composites

When pure epoxy and ultra-high molecular polyethylene (UHMWPE) fiber reinforced Nano epoxy in the form of bundle were prepared and tested for tensile properties. This testing was done to increase the effect of adding Nano additives to the resin to show the possible outcomes or degradation to the attribute. The result shows the tensile tests on different types of UHMWPE/Nano epoxy bundle composites resulted in increase in the modulus of elasticity due to the addition of reactive Nano fibers(r-GNFs).The properties of fibers and matrix constituents depends upon the mechanical properties of a fiber reinforced composites. Modulus of elasticity depends in the volume fraction and by considering the three-dimensional surface plot hence it generates the two parameters which give indication to the change in modulus of elasticity with respect to the volume. The GNF Nano fibers and diluents butyl glycidyl are mixed together in the ratio of 1:50 by weight and kept for sonification for 3 hr in room temperature. In the result reactive Nano fibers (r-GNFs) in the presence of composites which effectively increases the strength. It is also observed that viscosity of the blend is influenced by the addition of the diluents.

Carbon Nano fiber/ phenyl ethyl terminated polyimide composite

Vapour grown carbon Nano fibers (VGCNF) were dispersed throughout phenyl ethyl terminated polyimide also known “triple A PI (triA-PI)”. The maximum specific surface area was obtained from Nano fibers. Nano fibers is measured to be 15 msq./g. It is a thermosetting polyamide which is newly developed the polymer shows excellent mechanical properties and high glass transition temperature , the increase in glass transition temperature was not compared to carbon Nano tubes which is multi walled. The experiments results shows that the Vapour grown carbon Nano fibers (VGCNF) can be used to control melt viscosity the glass transition temperature is increased by 10 degree during processes. In the addition of primary crosslink structure of polymers and Nano tubes the secondary network structure was formed. The resulting composites exhibited really good dispersion in the presence of Vapour grown carbon Nano fibers (VGCNF). the mechanical, thermal, and electrical properties have been tested on Nano fiber dispersion for different kind of thermoplastic polymers like PMMA, nylon , poly carbonate etc. the result include the increase in the tensile strength.

Nano alumina filled polyvinyl alcohol composites

The chemically treated sisal fiber powder was prepared with and without Nano alumina filled polyvinyl alcohol (PVA). By solution casting technique the films of bio composite were prepared. The mechanical properties of the bio composites films has different weight percentages of treated sisal fiber in the presence of Nano alumina powder or not in the presence of Nano alumina powder which is determined by the tensile tester. For chemically

treated sisal fibers powder the values for PVA composites were higher than the values of untreated sisal fiber powder composites. Increase in the tensile strength is done by the addition of Nano alumina. By using scanning electron microscope the surface morphology of PVA composites films were observed. To determine the processing temperature range the analysis of thermal properties of composites is necessary hence the result shows firstly, the reduction of tensile strength of sisal fiber powder composites for treated and untreated. Second, the tensile strength of the composite is also increased by adding Nano alumina third, Nano alumina filled sisal powder PVA composites the elongation values are found to be minimum.

Bamboo polyester composite with coconut Nano filler

Using the bamboo fiber and polyester resin reinforced has a very positive effect in the development of the composites. With an angle orientation of 0/90 degree with woven bamboo natural fiber with coconut shell powder in Nano size reinforced the tensile properties have been tested. Before and after absorption of water test on the composites the tensile properties has been tested. Hence the absorption test shows the deflection in the tensile properties. Bamboo fiber can be chemically treated to reduce the deflection in tensile properties. It is also observed that when it is compared to the all other natural fibers the bamboo fiber absorbs more water than the rest of the natural fiber. Fiber which is made from bamboo has high tensile strength. The addition of silane coupling agent to the bamboo fiber with rubber matrix will increase the adhesive properties and also enhance the tensile strength and shear strength. When 30% of coconut shell powder to Nano scale used as filler with polyester composites increase in the young's modulus, tensile strength and also increase in the absorption property. Coconut powder is used as a filler material. The main objective of the work is to modify the properties of bamboo FRP composites and make suitable for outdoor

Sic Nano particle GFRE composites

Introducing the Nano fillers in the composites has very good effects on the mechanical properties in this the effect on the vibration properties, flexural and interfacial of matrix epoxy and glass fiber reinforced (GFRE) were investigated. The optimum Nano particles were sequence stacked by the unidirectional GFRE and quasi-isotropic GFRE were hybridized. The flexural strength of GFRE and good fiber/Nano phased matrix were demonstrated by interfacial bonding. the shear stress with different orientation between the two layers which were adjacent of ductile GFRE/SiC were results in decreasing in the flexure strength hence the stacking sequence increase In the interfacial friction energy. Sic Nano particles were introduced in these 12 composites were made with GFRE to investigate the flexure strength and interfacial bonding. Therefore, the flexure strength of SiC was improved. The ductility of GFRE and SiC composites maximizes the shear between the two layers. And non-destructive testing also done in this work

Low density polyethylene/ Nano-ZnO composites

The two components from which the composite is made are the titanate coupling (105, 101, TC-F) and silane coupling agent (KH-570) are used as a modifiers. Low density polyethylene is added to the nanometre zinc oxide which is modified by silane coupling agent or titanate coupling (105, 101, TC-F). Lastly the electrical breakdown of the properties of the composites are investigated. When the content was 3% of Nano-ZnO then the breakdown field strength of the composites is more than origin of 11% of LDPE. Smaller the size of ZnO particles, the more is the breakdown strength of Nano composites with the equal content of Nano-ZnO. The electrical breakdown strength of Nano composites with Nano-ZnO which was treated by titanate coupling (105, 101, TC-F) agent is less than those with Nano-ZnO treated by silane coupling agent (KH-570). Infrared spectrum is also improved by the combination of zinc oxide and polyethylene macromolecular chain. Preparation of composites is done by sol-gel method, blending method, interpolation between the layers, in-situ polymerization. From breakdown test we noticed that by adding zinc oxide to polyethylene materials the breakdown field strength get different results.

Alumina epoxy Nano-composites

In the application as insulation in power equipment the plain epoxy resins or resin impregnated cellulose have found. By using inorganic oxide fillers of microscopic dimension their performance has been improved. To further enhance the dielectric properties the Nano-particle doped in epoxy insulation came into use. The dielectric investigations into epoxy Nano-composites are made with presence of metal oxides. Efforts have been made to the Nano composites which improves the dielectric properties in a cost effective way for increased workload and the compactness of electrical machines. Polymers are modified physically by doping them with selected Nano particles and to synthesize and design new Nano composites dielectrics with improve electrical properties. In the preparation of Nano composites it is necessary to vacuum dry the Nano particles, the Nano particles were washed with mineral water and later in N-hexane and also prepared by mixing in the bulk process. Hence result signified that epoxy doped with Nano particles of metal oxide appear to show drastic improvement in the dielectric properties.

Nano-silica/Epoxy composites

The characteristics of electrical breakdown in inorganic Nano-silica/epoxy composites are demonstrated. The significant impact on electrical breakdown strength of Nano-silica/epoxy composites is shown by Nano silica. The appropriate amount of inorganic Nano silica can enhance the breakdown the breakdown strength of the composites, but extra amount fillers show different and opposite effect. The Percolation and interfacial characteristics are used study the peak value obtained on the curve of the break down behaviour of the Nano composites. The percolation network is formed by the interfaces between epoxy matrix and Nano-particles. Modified Nano silica particles with silane coupling agent are effective to form the molecular interaction between the epoxy and Nano-particles. Therefore as a result the break down strength of epoxy is less than of Nano particles. And the break down strength of modified silica is higher than the composite which is not modified.

Conclusion

In this paper we have discussed about how the reinforce or composite has improved the mechanical properties like tensile strength, flexure resistance, viscosity, modulus, and absorption tests are done. In Cement composites with Nano/micro carbonized bagasse fibers. Cement paste was added to the bagasse fiber, composite was made and in result it is demonstrated that the flexure resistance is increased, as per Polyester Nano composite fibers polyester was added to zinc oxide to make the composite which tends to increase the antibacterial properties to make it use in hospitals for decrease the transfer of disease. In Poly (lactic acid) bio composites reinforced with kenaf fibers the composite was made with the combination of poly lactic acid and kenaf fibers hence kenaf-PLA composite was formed the result determined that the flexure strength and modulus was significantly enhanced. As in UHMWPE/Nano epoxy bundle composites and Carbon Nano fiber/ phenyl ethyl terminated polyimide composite the bundle was tested for increase in the tensile strength in the presence was Nano fibers tensile strength increases. chemically treated sisal powder filled polyvinyl alcohol (PVA) bio composites the sisal powder was mixed with polyvinyl alcohol from which the elongation values was found to be minimum and lastly bamboo fiber was mixed with coconut shell Nano fiber to make a composite to enhance the mechanical properties young's modulus, tensile strength and also increase in the absorption property to make it suitable for outdoor purpose. Nano particle type effect on flexural, interfacial and vibration properties of GFRE composites which enhances the flexure strength and interfacial bonding. In Alumina and silica based epoxy Nano-composites for electrical insulation dielectric properties has been improved in the presence of metal oxide. As in Break down properties of low density polyethylene/ Nano-ZnO composites electric break down properties has been improved, Infrared spectrum is also improved by the combination of zinc oxide and polyethylene macromolecular chain. And in Percolation and interfacial characteristics on breakdown behaviour of Nano-silica/Epoxy composites the breakdown strength of modified silica is enhanced than non-modified one.

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