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Impact of Nanomaterials on the Properties of Biocomposites Material-Review

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Abstract:
The role of nanomaterials in the development of biocomposites is very crucial. It has been seen in the studies that it has been creating huge impact on the properties of biocomposites material. In field of material science enormous research work has been taking place to develop eco-friendly efficient biocomposites material. The industrial sustainability, eco-efficiency, and green chemistry are guiding principles for the development of the next generation products and processes. Considerable growth has been seen in the use of biocomposites material in the domestic sector, building materials, aerospace industry, circuit boards, and automotive applications over the past decade, but application in other sectors until now has been limited. Nevertheless, with suitable development, the potential exists for biocomposites to enter new markets and thus stimulate an increase in demand. Many types of natural fibers have been investigated with polymer matrices to produce composite materials that are competitive with synthetic fiber composites which require special attention. The Nanomaterials can be used to prepare fiber-reinforced polymer composites for commercial use and have marketing appeal. The growing global environmental and social concern, depletion of petroleum based resources, and new environmental regulations have forced the search for new biocomposites, compatible with the environment. Many references to the current status of research work on the impact of nanomaterials and applications of biocomposites are cited in this review.

Keywords:

Nanomaterials, biocomposites, Mechanical properties, Nanocomposite, Green chemistry

I. Introduction:

Nanomaterials play an important role to enhance the efficiency of biocomposites material. Nanoparticles have an extremely high surface to volume ratio which dramatically changes their properties when compared with their bulk sized equivalents. It also changes the way in which the nanoparticles bond with the bulk material. The result is that the biocomposites can be many times improved with respect to the component parts. Some nanocomposite materials have been seen to be 1000 times tougher than the bulk component materials. Nanomaterials are in the various forms and dimensions as per size and shape details have been given in the Figure 1.1, this figure shows that the classification of nanomaterials in the structural and morphological form. 0D, 1D, 2D and 3D, as structure change application changes.

Table 1.1 *Classification of nanostructure based on size and morphology*

Classification of nanostructure based on size and morphology			
0 D	**1 D**	**2 D**	**3 D**
Nanoparticl es	**Nan owire**	**Nanopl ates**	**Nanonetwork**
Nanosphere	**Nan otube**	**Nanost ars**	**Carbon nanocages**
Nanocrystal	**Nan obelt**	**Nanodi sc**	**Nanofilm (multilayer)**
fullerene	**Nan ofiber**	**Nanofil m**	**-**
Quantum dots	**Nan orods**	**Monol ayer**	**-**
Nanocluster s	**-**	**-**	**-**

One of the key advantages of Nanocomposites over conventional composites is the fact that the above improvements are achievable with significantly lower additions of nanofillers versus conventional composites reinforced with micro-sized reinforcement to achieve a similar level of improvement. Typically nanoclays replace talc or glass fillers at a 3:1 ratio, with 5%–8% of a nanoclays replacing 15% of glass filler. As an example, a 3%–5% addition of nanofillers is needed in Nanocomposites versus conventional talc reinforced composites which require significantly higher filler levels, 10%–50% [p/w], to achieve a similar level of improvements.
The key categories of automotive applications of polymeric Nanocomposites to date are body frames, interior and exterior body parts, power train, suspension and breaking systems, exhaust systems, fuel and other fluid lines, paints and coatings, lubrication, tires, and electrical/electronic equipments.

Table1.2 *provides an outline of gains in Nanocomposites properties in compare on with the counterpart micro-filler reinforced com*

Gains in Nanocomposite Properties versus Standard Composites			
Sr. no	properties	Micro{10-40%}	Nano{2-5%}
1.	Specific density	1	0.5 -1.0
2.	Tensile strength	1	1.5-2.0
3.	Elastic modulus	1	4-5
4.	Impact strength	1	0.5 -1.0
5.	HDT	1	1.5-2.0

Nano based biocomposites material is especially considered for food packaging. Its applications have been the subject of interest in recent studies, showing that such scheme of formulations would be the real advantage for research scientist and thereby society through industries. Several review articles highlight the need for further research and development in area such as processing, formulation characterization and determination of functional properties with risk assessment in context of biodegradability. The conclusion and outcome from such research and development is a need of an hour. For food packaging materials it has been found that nano-biocomposites should be used in minelayers or multilayer form. Efficiency of the biocomposites material may increase by altering the composition ratio of ingredients in the product for that purpose enormous research and development work need to conduct in laboratories.

II. Methods have been suggested for the preparation of biocomposites*:*

Blending: is normal practice which has been traditionally preferred every time it's simple and easy methods to prepare biocomposites. Polymers can be directly mixed with each other mainly by two methods, i.e. melt blending and solution blending. As the melt blending method is both efficient and environmentally friendly, researchers have preferentially focused on the melt blending as compared with the solution blending method. As the particle load increases, the polymer does not melt or the melt polymer is overly viscous meaning that both the melt and solution blend methods become infeasible. To overcome this situation, a solid blend method has been developed which avoids thermal and solvent problems.

General polymerization technique*:* The general polymerization method for preparation of nano-biocomposites involves three main steps—the preparation of additives and surface modification, the dispersion of additives into monomer, and then solution or bulk polymerization. This method has advantages over other techniques such as better efficiency, higher speed and better performance of the formulated product

- Photo polymerization,
- Solution polymerization,
- Emulsion polymerization,

- Surface-induced polymerization

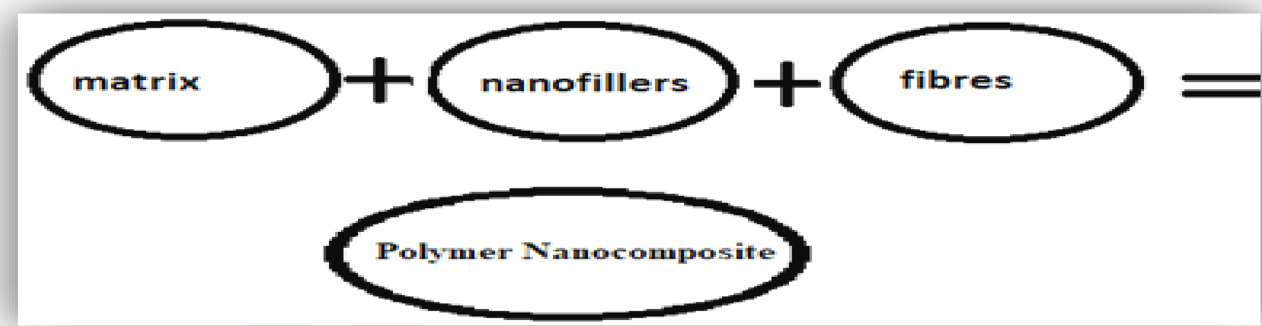
a. Interfacial interactions: It plays a key role in the construction of nano-composites. Two routes have been developed for the grafting of polymer chains at the particle surface that are known as grafting-to and grafting-from techniques.

b. Grafting method: This method involves chemical reaction between the reactive groups on the substrate surface and the functionalized polymer.

Processing step of reinforce nanomaterials

Such polymer grafting to methods have been widely used for solid surface modification. A thin polymer layer grafted to a solid substrate can significantly affect the properties of the polymer surface such as lubrication, friction, and wet-ability, adhesion and biocompatibility Grafting-from method: The grafting-from polymerization procedure is dramatically effective for preparing nano-composites. Solid surfaces can be modified directly using an immobilized initiator.

Blending:



Blending enhances the mechanical properties of biocomposites materials that is strength, toughness, resulting texture ultimately it depends on phase morphology.

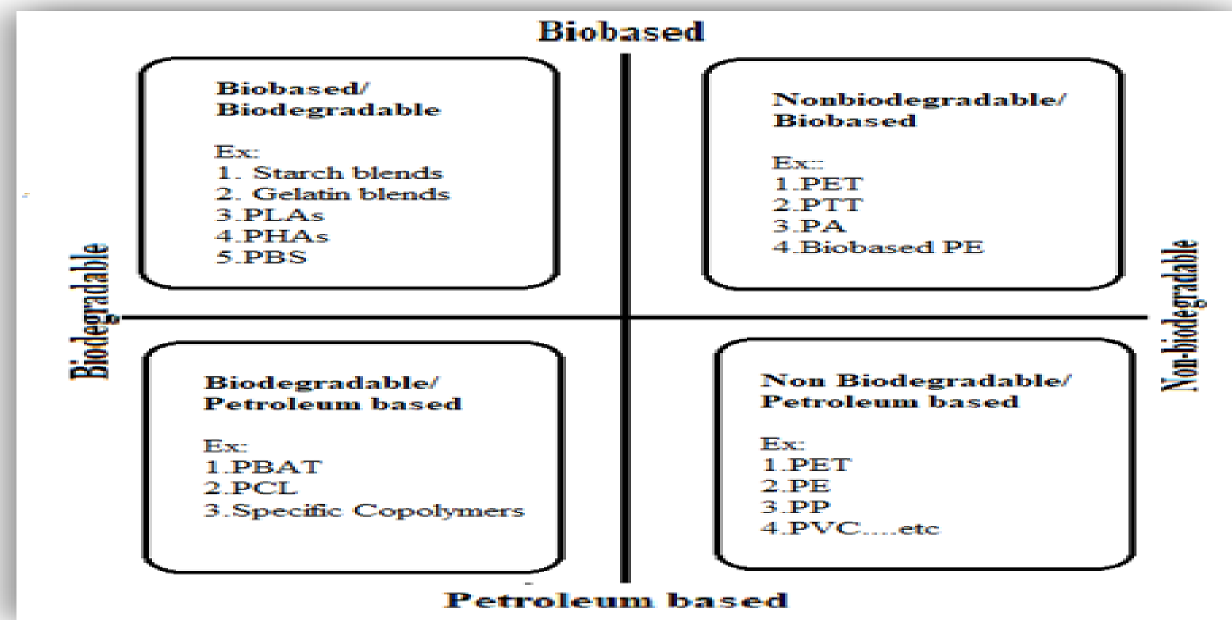


***Table 1.3** Classification of Composite materials:*

On the solid substrate the initiator is immobilized and the polymer layer is produced via in situ polymerization. Their test results showed poor compressibility of CNT/CNF grown on fibers and the researchers suggested a need for an optimization method over the current FRC- processing technologies. In continuity to the above work, Mr. Lomov conducted another study on compression resistance and hysteresis of carbon fiber tows with grown carbon nano tubes/nano fibers. The test results conformed substantial increase of the compression resistance of the yarns after the growth of CNT/CNF, associated with the addition of catalyst and thermal treatment were the promising reasons for an increase in the compression resistance of yawns. Jeffery Baur synthesized carbon nanotube grown on high performance carbon fibers to test the tensile properties of the fibers. For the study, higher density multi-wall carbon nano tubes were grown on T650 and IM-7 carbon fibers by thermal chemical vapors deposition (CVD) process. Promising tensile properties were seen under thermally stable non uniform fiber at appropriate growth conditions. In an experimental study, an exploration of the inherent sensing and interfacial properties of car- bon nano fiber and nano tube/epoxy composites was made by Joung-Man Park their investigation was carried out with filler content using electrical micro-mechanical tests. Inherent sensing of carbon nanotube/epoxy composite was found to be better than carbon nanofiber/ epoxy composite. The mechanical properties and apparent modulus were also found to be significant for carbon nano tube/epoxy composite among three carbon nanomaterials chosen for study. The interlaminar properties of halloysite nanotube filled carbon fiber-reinforced epoxy was studied by Jingshen which revealed improvements in the interlaminar shear strength of around 25% obtained with 5% of halloysite nanotube, significant improvements in the fracture toughness under mode-I and mode-II loadings were also noted by the addition of halloysite nanotube. Furthermore, examination of the hybrid composite under SEM revealed non-uniform dispersion of halloysite nanotube in the epoxy matrix.

The choice of a matrix depends on several factors such as application, compatibility between the components, processing, and costs. Significant research on starch as a matrix for Nanocomposites has been done, with the matrix mechanical properties changing dramatically according to the starch botanical origin, plasticizer addition, and filler choice.

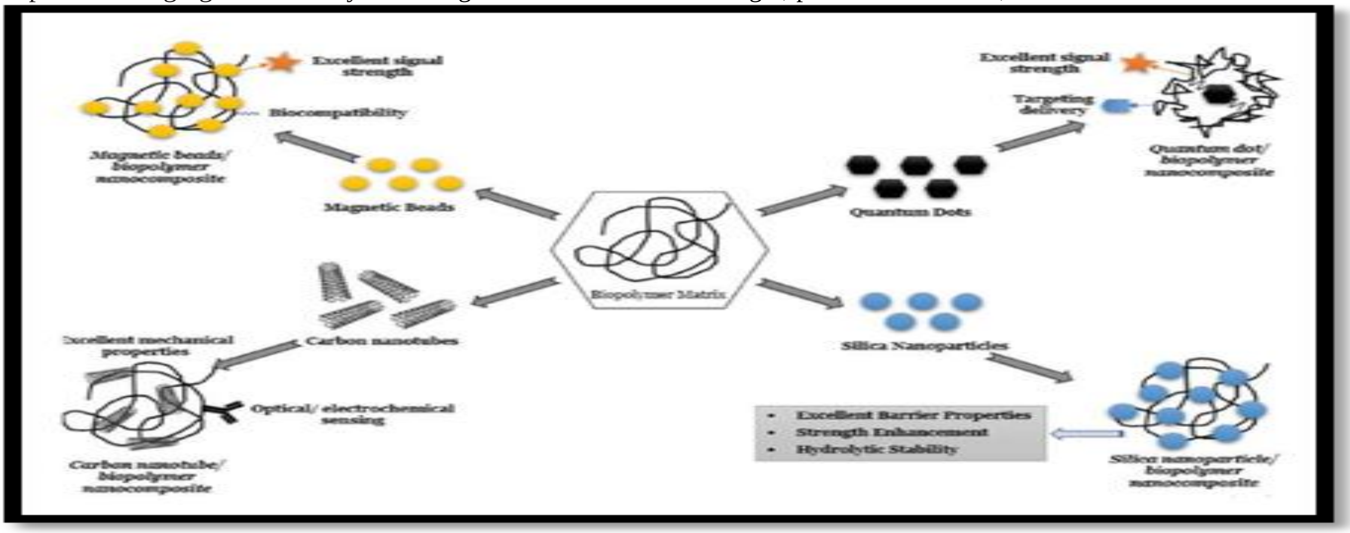


Diagram1.1 *shows that correlation between ingredient and properties thereby applications*

III. Applications: Nanocomposites are useful in various applications and are currently being used in a number of fields. Recently identified areas for new the applications of Nanocomposites materials include thin film capacitors for computer chips Solid polymer electrolytes for batteries Automotive engine parts and fuel tanks Impellers and blades Oxygen and gas barriers Food packaging and many more some are given in details here as explained. Nano-biocomposites have a wide range of applications in agriculture and biomedical sciences Tissue engineering represents one important application in biomedical science. Tissue engineering is the research development of the three-dimensional structure and that can serve to support the regeneration and replacement of tissues in a natural way. Biopolymer scaffolds and nano-biocomposites potentially offer themselves as key materials in tissue engineering Nano-biocomposites can be used in combination with imaging agent to exploit magnetic resonance imaging (MRI) for the diagnosis and detection of various diseases such as cancer, tissue and bone injury and infections Biopolymer nano-composites can be used to support permanent or temporary prostheses of tissue replacements, surgical operation and artificial organs. The materials can also be used for targeted delivery of hormones, vaccines, specific targeted delivery of insulin and as anti-cancer drug controlled-release devices.

Biosensors are electrochemical devices that are capable to provide quantitative information using receptor (biological recognition element) directly connected with a transduction element reported nano-biocomposites as surface coatings in biosensor devices and therefore may have potential significance in this area of research. Heavy metals have received extensive attention due to their toxic effects even at low concentration. Various methods (solvent extraction, ion-exchange, precipitation, reduction and membrane-process) have been applied to remove heavy metals from water. Recently, one of the efficient and cost-effective methods is the sorption of heavy metals via nano-biocomposites However; the mentioned applications require further improvement before their effective use with nano-biocomposites for sorbents of heavy metals. The use of nano-biocomposites for food packaging combines two of the most active research areas on materials in contact with food. Thus, applications of nano-biocomposites could help to provide new food packaging materials with improved mechanical, barrier, antioxidant and antimicrobial properties

IV. Summary: Modification of biopolymers through innovative technologies, such as nanotechnology, is an important challenge for material scientists. The formulation of nano-biocomposites is an effective way to enhance their properties while improving renewability and biodegradability in order to reduce the carbon footprint and the participation of packaging materials in the MSW

V. Conclusion:

Described research work reviews trends in the use of nano-composite and bio-composite materials in advanced applications in numerous fields of engineering such as automobile, aviation, adhesive, electronic industries, and building, showing that nano-composite and bio-composite materials are now used in many significant applications, from high-tech systems such as aviation and aerospace, to common daily applications such as bio-sensors and food packaging. New high-performance materials have encouraged researchers to utilize bio-degradable elements to produce materials with potential ecological importance in terms of overcoming environmental challenges, offering a promising prospective for composites based on natural materials as opposed to industrial materials. The interactions between nanoparticles at different length scales and matrix chains represent a challenge and a more comprehensive understanding. Therefore there is requirement of tailor the properties of composites for certain applications. The uniform dispersion of nano-materials, good interfacial adhesion, and homogeneity in composite during the preparation process are critical, though these can be achieved through surface modification of nanoparticles, including using coupling agents. The final remark on this project is that the compatibility of the ingredients that is matrix phase and dispersed phase is important factor for the formulation of nanomaterial based biocomposites materials, their ratio, proportion, sequence of addition, working conditions. These are the challenges researcher have been facing off to get efficient biomaterials.

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