

# **A REVIEW -POLYMERIC NANOCOMPOSITES**

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## I. INTRODUCTION

**Nanocomposites** are the materials consists polyphase solids with one, two or three dimensions less than nano scale. In these materials the distance between two phases repeated on nano scale. [1-3].

Idea about nanocomposites to builds up the materials with nano dimension that provides extraordinary flexibility with enhancing physical properties.

Nanocomposites can be defined as the materials may be colloidal, gels, porous and copolymers,

It is the combination of matrix and reinforcement phases possess different materials based on the structure and chemistry of the constituents. The properties like thermal, mechanical, optical, electrical and catalytical of nanomaterials significantly depends on the size limits of components.

For various properties like super magnetism, optical, magnetic and catalytic the size should be less than 100 nm, 50 nm, 20 nm and 5 nm respectively.

It is expected that nanocomposites exhibit extraordinary amended properties by the combination of matrix and reinforcements. The upgrading properties can be achieved effectively by interaction between the matrix and nanoparticles by appropriate dispersion of nanoparticles in matrix [4].

These materials have emerged as right alternatives to reduce the restrictions of micro and massive composites. The different bonding pattern appears in nano composites between matrix and reinforcement such as covalent bonding, ionic bonding, Vander Waals forces and hydrogen bonding.

The novel properties of nanocomposites such as exceeding design, flexibility, optical property create a synergy between the constituents with the demands of second phase nanoscale. The variation in the properties of nanocomposites particularly depends on type of matrix material such as dimension, nature of dispersion, shape, orientations and interface between matrix and second phase reinforcements [5]. The nanocomposite plays a wide role in biomedical applications such as drug delivery, biosensors, tissue engineering and stem cell variations. These composites are described to be novel materials of 21<sup>st</sup> century having exclusivity design and the novel properties, different from those synthesized by conventional methods [6].

## 1. Types of Nanocomposites

The types of nanocomposites depend on nature of matrix and reinforcement. The role of matrix material in composites to support reinforcement by fixing their positions. Reinforcement is responsible to enhanced physical properties such as mechanical and electrical of the composites.

## 2. Based on Matrix

These are the material in which the reinforcement is embedded. The classification of matrix depends upon the nature and source of matrix. It is further classified in three categories.

- a. **Ceramic Matrix-Based Nanocomposites:** Ceramic matrix-based nanocomposites are in which ceramic fiber embedded ceramic matrix. The covering of d-block metal oxides on ceramic based matrix provides the better qualities than metal and organic oxides. Theses are widely used in industries due to unaffected corrosion, bear to oxidation at high temperature and wear to resistance. The reinforced is embedded in matrix as in form of particle, fiber and voids [7]. Ceramic matrix-based

nanocomposites are widely used diagnosis, wear resistance on friction, aerospace and electricity generations.

- b. Polymer Based Matrix Nanocomposites:** The polymers are such type of materials that can be easily prepared, they are lightweight and appropriate mechanical properties. Conventionally they are prepared by embedded particle or fiber reinforcement [8]. The properties of nanoparticles greatly depend upon the particle size and their distributions in dispersed phase. The hardness and mechanical properties of these nano composites depends upon the degree of interaction between matrix and reinforcement.
- c. Metal Matrix-Based Nanocomposites:** It is referred to metal as matrix and ceramic as reinforcement material. The combination of ceramic along matrix provides the good ductility and cracking durability with low thermal extension coefficient good wear resistance. Nanocomposites metal matrix is suitable for making of materials, they are capable to bear high working temperature along with shear strength processes. The phase of reinforcements may be either particles or fibers, such  $\text{Al}_2\text{O}_3$ , TiC, SiC are used in aluminum metal-matrix composites and carbon fiber used in Magnesium metal-matrix composites.

### 3. Types of Reinforcement

A reinforcement must be hard and rigid than the matrix. The classification of nanocomposites further depends on the nature of reinforcement.

- a. Fiber Reinforcement Composites:** The fiber-reinforced composite is a composite building material that have three components:
- The fibers as the irregular or spread phase
  - The matrix as the constant phase
  - The fine outer phase section termed as the interface.

These are the progressive composites which consist the ingredients such as husk and shell of rice along with plastics. The strengthen fiber-based composites is formed by purifying, blending and intensifying the natural fiber obtained from cellulose waste. Various types of raw materials are used in the synthesis of polymer composites such as plant waste and rice waste.

Fiber-reinforced nanocomposites synthesized by two approaches the first is embedded of nanofiber into matrix that strengthen the nanocomposites, second by embedded nanomaterial into fiber based matrix. The composite performance is arbitrated by its structural parameter such as length, shape, alignment, and configuration of the fibers and the mechanical behavior of matrix.

- b. Laminar Composites:** In laminar composites the material various layers are bonded together. The two or more metals linked alternatively to show the bond order more than one. The bond order more than is necessary for specific persistence. The sandwich types of constructions consider into this class.
- c. Particulate Reinforce Composites:** Particulate reinforced composites state to a material involving of more than one individual constituents. The reinforcing component is embedded in a matrix for composite formation. Concrete is a decent sample of particulate reinforced composites. Cumulative of rough rock or stones is entrenched in a cement matrix. The aggregate offers toughness and strength whereas the cement acts as the ring binder to grip the structure composed. The different forms of particulate composites exhibit. The size of particulate materials are quite small in range  $< 0.25$  microns. The various examples are cut fibers, platelets, echoing spheres, or novel materials like Buckminster fullerenes or carbon nano-tubes.

The structural applications of particulate reinforce composites depends upon the capacity of binding interactions between reinforce and matrix materials.

The strength of particulate reinforces composites

The volume fraction, interparticle spacing and diameter of reinforcing material explain the composites strength [9]. Matrix composition effect the behavior of particulate matter composite.

#### 4. Dimensional Based Nanomaterials

On the basis on dimension nanocomposites are classified in subsequent category [10-11]

**a. Zero Dimensional Nanomaterials:** Dimensional based nanoparticles widely depend upon the dimension of nanomaterials. Zero-dimensional nanoparticle are those that have all dimension at nano scale. As per nanotechnology size is a remarkable property than can enhance physiochemical properties such as optical density.

By changing the size of nano-particles the variation in size, shape and in color that is responsible for bioimaging applications [12].

**b. One Dimensional Nanomaterial:** The nanomaterial which has one dimension out of nanoscale such as nanowire and nanotube.

The nanowire has the diameter less than 100 nm with hollow structure. The innovative nanotube is the uni-walled carbon nanotube (SWNT) containing of a single graphene sheet bowled up in a tube. Nanowire and nanotubes are the record constraining electrical conductors [13].

**c. Two-Dimensional Nanomaterial:** Two-dimensional nanomaterial is which have two dimensions out of nano scale such as silicate sheets. The silica films in recent years developed as novel two dimensional 2D materials. The two-dimensional structure consists two tetrahedral  $[\text{SiO}_4]$  connected through oxygen bridges.

Such type of arrangement is called silica bilayer as thinnest 2D two tetrahedral  $[\text{SiO}_4]$  stoichiometry. In nanosheets all bonds are saturated and substrate is interacted through van der Waals forces. In two-dimensional structure have hexangular honeycomb frameworks, point flaws and domain borders. By variation of substrate deposition parameter along with chilling technique and intercalating [14] makes viable tunable structure.

**d. Three-Dimensional Nanomaterial:** Three-dimensional nanomaterial is which have three dimensions out of nano scale such as zeolites.

The zeolites are small-compactness, crystal-like aluminosilicate ingredients stated as molecular filters, zeolites hold steady micropores of dimension from 0.3 nm to 2 nm.

However, the surface area can be increased by reducing the size of the crystals and rise the share of atoms on crystal surfaces [15].

## 5. Future Scopes

Nanocomposites materials offer excellent properties to expose them more attractive, multifunctional, potential applications in healthcare along with sensors and other systems.

These are globally future packaging materials. In this technology material cost are less, company makes their profit easily. Due to the product stability, it survives in supply chain for late

delivery to customer.

Nanocomposites have a wide range of applications in sports apparatus and conveyance vehicles [16-17]. The electronic devices now developed in nano range such as nano wires.

The conducting behavior of insulating polymer-based carbon nanotubes emerging topic of interest.

The diversity of polymer nanocomposites evolves various applications such as photovoltaic cell and photodiodes, super condensers, sensors, LED'S, field effect transistors, electromagnetic intrusion shielding, clear conducting coating, electrostatic dissipators, electro mechanic actuators and other electronic applications [18]

The polymer nanotechnology and nanocomposites to incipient biomedical and biotechnological applications is a speedily developing area. The updated behavior of polymer nanocomposites shows them good-looking for a diversity of biomedical and pharmaceutical applications like Drug delivery, Wound healing, Tissue engineering and Gene transfer. Due to their biodegradability and biocompatibility, they are also finding useful role in food packaging applications.

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