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REVIEW ARTICLE - MEDICAL TECHNIQUES

Nanocomposites for Prosthetic Dental Technology: A Systemic Review

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Abstract

To obtain the desired outcomes, nanotechnology employs approaches to control the shape, size, and texture of elements in the necessary nanoscale. It was previously used primarily in the areas of substance chemical production and physics; however, this has changed through the advancement of new technologies. Over time, biological scientists became aware of its numerous benefits and investigated them in their respective fields.
To assess current knowledge about nanocomposites and their applications in prosthetic dental technology.
On this topic, an electronic systematic review was conducted in various databases (Google Scholar research, Science Direct reports, PubMed studies, and Web of Science data), as well as a hand search of the scientific literature. From 2014 to 2022, published work was collected, analysed, and relevant articles were chosen for inclusion in this review. Nanocomposites and their applications in prosthetic dental technology have been reported in several studies. More than 36 papers were chosen for this review based on their applicability.
The findings suggest that current knowledge was adequate to recommend nanocomposites and their applications in prosthetic dental technology for routine laboratory use, with improvements in each of the current nanomaterials and procedures for the prosthetic dental technology.
Because of their physical and chemical properties, polymer nanocomposites were suitable for prosthetic restorations; however, careful processing methods, nanomaterials, laboratory skill, and a strict protocol for prosthetic restoration are required to improve the mechanical and physical properties.

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Keywords: Nanocomposites; Prosthetic Restorations; Nanoparticles; Nanodentistry, Biomaterials Implants.

1. Introduction

Prosthetic dentistry was a distinct branch of dentistry that deals with artificial teeth. Its popularity has grown as people's living conditions have improved and public awareness of oral health issues has grown [1]. Prosthodontics is the study of teeth for post-tooth loss procedures such as bridges, crowns, and dentures, as well as artificial teeth. Anomalies of the maxillofacial tissues, as well as temporomandibular joint prosthetics and periodontal disease prostheses [2]. The term "nano" refers to "one billionth," nano-technology cope-with biomaterials that were measured in billionths of a meter. A nano-meter was one-hundredth of the width of a single human hair or about ten hydrogen atoms across. Nanobiotechnology is the study of very small objects. Nanotechnology employs procedures to regulate the size and morphology of nanoparticles required for potential uses. It was previously used mainly in the areas of matter physics or chemical engineering, but as time passed, biological scientists identified and examined its numerous benefits in their respective fields [2].

The use of nanotechnology in dentistry was known as 'Nanodentistry.' It was trying to transform every aspect of dentistry. It consists of therapeutic and diagnostic tools that use nanomaterials to aid in the preservation of oral hygiene. Nanodentistry research was evolving holistically but slowly, thanks to the advanced discovery of symbiotic use of novel polymers, natural polymers, and natural polymers. Polymers, metals, minerals, and pharmaceuticals were instances of these raw materials. Because there are reasons to assume that nanocomposite restorations will be a significant biocompatible prosthodontic trend in the future [2]. However, nanobiotechnology was not limited to minor objects. Nanobiotechnology was a vast subject. Nanocomposites have recently emerged as viable alternatives to traditional bulk optical materials because they allow for on-demand customization of linear and nonlinear optical properties by adjusting the size, shape, and type of nano-inclusions [3].

Nanocomposites have made significant contributions to groundbreaking achievements in aerospace. Nanocomposite material advancement has resulted in improved fatigue strength, lightweight components, and radiation resistance [4]. To address these issues and improve the mechanical properties of PMMA denture bases, the inclusion of fillers and rubber particles in the PMMA resin matrix has been proposed [5, 6]. It integrates knowledge from biological science, chemical science, physical science, and other biomedical fields. Nanotechnology, according to Joseph and Morrison (2006), was the manipulation or self-assembly of single atoms, particles, or small molecules agglomerations into structures to produce substances and devices with innovative or significantly different characteristics [7].

Nomenclature & Symbols

PNCs	Polymer nanocomposites	CNT	Carbon nanotubes
NMS	Nanomaterials	PMMA	Poly methyl methacrylate
Al_2O_3	Aluminum oxide	HEBM	High energy ball milling
VARTM	Vacuum-Assisted Resin Transfer Molding	ZrO	Zircon oxide
CAS No.	Chemical-Symbol Number	MgO	Magnisum oxide
$nCaCO_3$	Calcium Carbonate nanoparticles	TiO_2	Titanium Oxide
SiO_2	Silicon dioxide	ZnO_2	Zinc peroxide
Cr	Chromium	NBT	Nano-Barium Titanate
CMCs	Ceramic Matrix Composites	Ni	Natrium
HA	Hydroxyapatite	MG	Maxwell Garnett
MMNC	Metal Matrix Nanocomposites	HFCVD	Hot Filament Chemical Vapor Deposition
NPs	Nano-Particles	PVD	Physical Vapor Deposition
CARB	Cross-accumulative roll bonding	ESD	Electrospray deposition
SLM	Selective Laser Melting	°F	Fahrenheit
CNTs	Carbon NanoTubes	W/Mk	Watts/meter-kelvin

Nanomaterials (NMs) are natural or man-made materials with dimensions ranging from 1 to 100 nm. When compared to their bulk counterparts. Because of their small dimensions and high surface-to-volume ratio, they have notable physical and chemical characteristics. Because of their unique and versatile physicochemical properties. Nanomaterials can be used in a wide range of fields, including bioscience, electronics, and materials science [8].

Most important dentures were used to improve alveolar function and development to maintain the wearer's health and appearance. There are three types of denture materials: resin, ceramics, and metal. When designing a dental prosthesis that will come into contact with the oral mucosa, these considerations must be kept in mind. Colors for dental materials can be developed and maintained over time. It should only be administered orally, be bifunctional, and have a high level of biocompatibility and security. However, due to the material's nature and prolonged use in a wet environment, several issues, such as pigment adhesion, colour change, and aging fracture, may occur during denture wear. Because of the unique structure and properties of nanoparticles, which are gaining popularity in their application, there is ongoing research in the field of Nano. The surface of the nanoparticle has more atoms with liberated surfaces than the cleus. They have more core than surface atoms and are more controllable and usable than macro or microparticles. Nanobiotechnology combines solid-state science, chemical engineering, biomedical engineering, biochemical, bioengineering, and biomaterials [9].

Nanobiotechnology is the subject of research, application, and matter regulation at the nanoscale. All aspects of nanoscale science, engineering, and technology were covered. Future nanotechnology advancements will have an impact on every aspect of human life. The study, application, and control of matter at the nanoscale were known as nanotechnology. All aspects of nanoscale science, engineering, and technology are covered. Future nanotechnology advancements will have an impact on every aspect of human life. Matter, including gases, liquids, and solids, is capable of exhibiting unique physiochemical properties and biological features at the nanoscale, which differ significantly from bulk ingredients and single atoms or molecules. Some nano-structured ingredients are tougher or have individual magnetic properties than other forms or dimensions of the same substance, while others are better at transmitting heat or voltage [10].

In recent decades, nano-technology has been viewed as an applied technology in a variety of fields. A convergence of various sciences has resulted in the development of nanotechnology, which allows for work at the atomic level and the creation of new structures. Nanotechnology is the production of nanosized elements and devices, as well as their control to exploit their unique properties. Using this definition, it was discovered that nanotechnology has a diverse set of uses in life sciences, engineering, as well as medicine, with one application being the environment [10, 11]. There are numerous interactions between polymer chains and the surfaces of nanofillers in nanocomposites, including chemical, physical, long-range, and short-range interactions [11, 12]. Because of its improved mechanical properties, biocompatibility, and stable structure, it has been widely used in various fields of dentistry as a novel nanoparticle [12]. Nanoparticles (NPs) play an important role in various fields and were extensively studied due to their excellent physical and chemical properties [13, 14]. Nanostructured materials and nanotechnology in general have received considerable attention over the last few decades, but there was considerable overlap in techno-economic domains [15-17]. The goal of this study was to educate readers about the application fields of nanocomposites and how to strengthen polymer and ceramic materials.

2. Procedures and Materials

Google Scholar, PubMed, Science Direct, and Z-library were used to search for the uses and applications of nanocomposites in prosthetic dental technology. The inclusion criteria included, among other things, research articles about nanocomposites published between 2014 and 2022, articles about additive effects, and articles about dental applications or biomaterials implants. The current work attempts to present research challenges and future directions in addition to reviewing the existing literature on nanocomposites. The current nanocomposites study will be useful for practitioners interested in conducting additional research in all areas of dentistry, particularly prosthetic dental technology.

3. Nanocomposites Classification

Composites were made up of two phases that have been blended/mixed to achieve the desired properties for specific applications. Nanocomposites were a subset of composite materials that include at least one nanoscale component. Due to a high matrix-to-filler interfacial area (the so-called "Nano effect") and greater aspect ratio, the arena of nanocomposites with unusual property combinations and design possibilities at a very low concentration of fillers has gained a special status in recent years. Mother Nature's best examples include bones, shells, and wood [1].

The number of dimensions in the nano range influences how nanoparticles were classified as follows: When used as the most common source of zero-dimensional (0D) nano-materials, (0D) nanoparticles have all dimensions within the nanoscale, i.e. no dimension was larger than the nanoscale, a hundred nanometers. Metal, ceramic, or polymer nanoparticles can be homogeneous or porous. [2]. Nanoparticles with a single dimension (1D). It has at least one nanoscale dimension, for example. This results in needle-shaped material properties with a single dimension at the nanoscale. Nanomaterials used to make one-dimensional nanomaterials include nanoplatelets, nanorods, nano-clays, and nanosheets. Furthermore, two-dimensional (2D) nanoparticles have two dimensions at the nanoscale. Nanofiber ingredients, nanotube ingredients, nanorod ingredients, and whisker ingredients were all found in two-dimensional nano ingredients. Carbon nanotubes were an excellent example of two-dimensional particles. [2] Nanomaterials. Three-dimensional (3D) nanomaterials, on the other hand, have all three dimensions at the nanoscale this can be seen in Fig.1.

Agglomerated nanoparticles and nanoparticles make up the three-dimensional (3D) nano ingredients. Nanoelements can be crystal-like, amorphous, or poly-like crystalline in nature. It can be composed of single-phase or multi-phase biochemical components. It comes in a variety of shapes and sizes and can be metallic, ceramic, or thermoplastic [2].

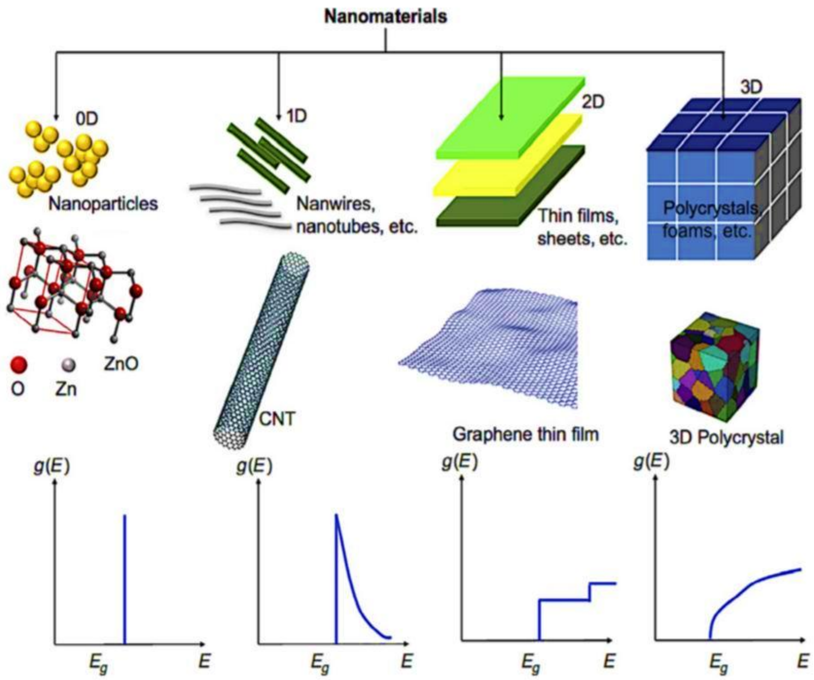

Fig. 1. Schematic representation of zero-dimensional (OD), one dimensional (1D), two-dimensional (2D), and three dimensional (3D) nanomaterial and density of electron states of a semiconductor by varying dimension [19]

The properties of several nano-additives used in the manufacture of nanocomposites dental polymers were evaluated, as shown in Table 1.

Table 1. Describe the properties of some nano-additives that used in nanocomposites dental polymers [6, 21]

Additives	Properties	References
$nTiO_2$	Titania nanoparticles strengthening with 1wt. % by weight resulted in a significant boost in tensile strength. The tensile strength declined as the number of $nTiO_2$ nanoparticles raised. The addition of $nTiO_2$ improved the PMMA denture base's durability, tensile strength, as well as hardness.	[20]
Silica and Prepolymer nanoparticle	Prepolymer incorporation improved the flexure of PMMA in all concentrations when compared to the control group and silica addition group. Increased filler concentrations led to enhanced mechanical characteristics of the acrylic resin.	[21]
$nZrO_2$	As the rate of $nZrO_2$ addition increased, so did the specimens' water sorption/solubility values. Even though the addition of $nZrO_2$ had a detrimental effect on some material characteristics.	[22]
Silanized nZrO	Even before silanized zirconium oxide nanoparticles are added to the high-impact heat-cure acrylic resin, they enhance impact strength, bending strength, and surface hardness while decreasing total water sorption and solubility.	[23]
$nZrO_2$-nAL_2O_3 mixture	Increased impact and transverse strength considerably, but not hardness, increases surface roughness and reduces denture support.	[24]
TiO_2-Al_2O_3-SiO_2 mixture	Reduced coefficient of thermal expansion and contraction and E-modulus	[25]

Glass fiber and nano-Filler	The addition of nano-filling to repair resin improved both flexural strength and impacting strength.	[26]
$nAl_2O_3 + nTiO_2$	Both compressive yield strength and fracture toughness gradually improved, showing the greatest improvement in hardness and lowering the friction coefficient and wear rate.	[27]
Modified nano-HA fillers	The addition of two percent of nano-modified HA particles improved the impact strength, surface hardness, and water sorption and solubility significantly. In contrast, the very same intensity decreases transverse strength and enhances surface roughness.	[28]
$nZrO_2$	Depending on the size of the ZrO_2 grains used, the addition of nano-ZrO_2 rises the flexural strength of the composite with the PMMA matrix.	[29]
Nano-Barium Titanate (NBT)	The NBT/PMMA nano-composites had higher surface hardness and lower surface roughness due to the consistently dispersed and extremely condensed NBT particles.	[30]
TiO_2+Al2O_3	The addition of TiO_2+Al2O_3 nanoparticle mixture to PMMA (high-impact) material improved the flexural and impact resistance of the high-impact acrylic resin.	[31]
$nCaCO_3$	An addition of four percentages of Calcium carbonate nano-materials to PMMA significantly improves radiopacity without affecting the colour.	[32]
Silanized nAl_2O_3 + Plasma	It enhanced impact strength, surface roughness, as well as thermal conductivity	[33]
$nSiO_2$ and nAl_2O_3	In contrast to standard artificial acrylic teeth material, $nSiO_2$-modified teeth material exhibited an important decrease in weight loss, whereas nAl_2O_3 adapted teeth material illustrated a non-significant boost in weight loss.	[34]

3.1. Types of nanocomposites in prosthetic dental technology

Nanomaterials were divided into three categories based on their matrices: Nanocomposites include ceramic-matrix nanomaterials, metal-matrix nanostructured materials, and polymer-matrix nanocomposites. Polymer-matrix nanocomposites (PNCs) were better suited for smart textile applications due to their flexibility and conformability with textiles. Because of their ease of manufacture, lightweight, ductile nature, high strength, better resistance to corrosion, fire, and acids, higher fatigue strength, and other benefits, PNCs have achieved a phenomenal status in industrial and real-world applications. Based on their heat response, polymer matrices could be classified into two major categories: I thermosetting polymers as well as (ii) thermoplastic polymer materials, which are discussed in the sections that follow [2].

3.1.1. Polymer nano-composites

Polymer nanocomposites are components in which polymer provides a matrix and nano additives utilise as reinforced materials. 1D additives (nanotubes and fibres), 2D (layered materials such as clay), and 3D additives are all viable options (spherical particles). Polymer nanocomposites have gotten a lot of attention in academia and industry because of their exceptional mechanical properties, which include elastic modulus strength and stiffness with only a low concentration of nano additives. Additionally, polymer nanocomposites have an outstanding barrier, important considerations involve oxidation resistance, wear resistance, and magnetic, electrical, and spectroscopy properties [2]. Plastic nanocomposites are composite materials produced up of one or more nanofillers distributed across a whole plastic matrix. The overarching goal is to combine polymer processability with superior nanofiller material properties to create nano-composite materials with vastly improved structural features. The significant increase in the interface formed between the nanofillers and the polymeric materials when at least one distinguishing feature size of the fillers was reduced to the nanometer scale was one emerging concept from nanocomposites [11].

A typical polymer-composite reinforcement consists of a plastic (matrix) and a stuffing. Polyamide is a thermoplastic polymer, for example, and carbon and glass fibre are popular reinforcing materials. Carbon materials are widely used in the aerospace sector as reinforced materials [2]. Carbon materials were also commonly used as reinforcement materials in the aerospace sector. The application determines the type of reinforcement material used. In most cases, weak intermolecular forces hold the polymer matrix and fillers together, but adhesion is also used in some cases. When the filler material in a matrix was dispersed on an atomic or molecular level (nanometric level) and chemical bonding with the matrix material occurs, remarkable improvements in the mechanical properties of the composite material, as well as some new and unexpected or exotic properties, can be achieved. To achieve high strength, clay minerals (montmorillonite, saponite, hectorite, etc.) were used as filler materials [2]. A layer of silicate clay particles appears to be about 1nm thick and composed of platelets about 100 nm wide. As a result, the aspect ratio was quite large. With a diameter of 13 mµ and a length of 0.3 mm, glass fibre is 4 x 109 times the size of a typical silicate layer.

Polymers have numerous advantages, such as their lightweight, high durability, ease of processing, corrosion resistance, ductility, and low cost. Polymers have poor mechanical, thermal, and electrical properties when compared to ceramics and metals. Polymers also perform poorly in terms of gas barrier, heat resistance, and fire performance [2]. Polymers have a lower coordination number than ceramics and metals, as well as an ultra-light carbon and hydrogen atom backbone, making them suitable for use as structural components and construction materials in lightweight applications such as automobiles, defensive performance, aerospace, and electronics. In some polymer matrix nanocomposites, previously unknown combinations of properties have been observed, such as the addition of a very small amount of mica-type silicates (0.03-0.04%) in epoxy, which increases modulus in the rubberized phase [2]. It boosts modulus in the rubberized region by about 450%. The development of nanocomposites had also resulted in significant advances in nanomaterials chemical processing [2].

3.1.2. Ceramic matrix nano-composites

Ceramic matrix nano-composites with at least one nano dimension phase are a novel production of engineering materials with a wide range of industrial applications. Nano-ceramic composites have exceptional electrical and mechanical properties due to their microstructure. Many methods for attempting to prepare ceramic matrix nanocomposites have been documented in the literature. Micro-composites are commonly created using traditional powder methods, polymer precursor routes, spray pyrolysis, chemical treatment such as the sol-gel process, colloidal and precipitation approaches, and template synthesis [2]. Al2O3/SiO2, SiO2/Ni, AL2O3/TiO2, and Al2O3/SiC are examples of ceramic matrix nanocomposites. Since their discovery, carbon nanotubes (CNTs) have been widely used in the manufacturing of polymer nanocomposites. Al2O3/CNT and MgAl2O4/CNT are two examples of CNT-based ceramic matrix nano-particles [2].

3.1.3. Metal matrix nanocomposites

Nanoparticle-enhanced materials composed of a ductile metal or alloy matrix reinforced with nanoparticles appear to be matrix alloy nanocomposites. The physical, chemical, and mechanical properties of these composites, which are made of a metal/alloy matrix stuffed with nanoparticles, differ significantly from the matrix material. Nanoparticles are commonly used to improve wear resistance, mechanical properties, and dissipative properties. Metal matrix nanocomposites, which have a wide range of applications in components due to their superior properties due to nanoparticle embedment, are currently being investigated by researchers. At the nanoscale, particle interaction with dislocations becomes significant, resulting in significant improvements in mechanical properties. By attempting to act as a dislocation barrier, the nanoparticles improve mechanical properties. Spray pyrolysis, liquid metal infiltration, and electrolysis were the most commonly used processing methods. By intending to act as a dislocation barrier, the nanoparticles improve mechanical properties. Spray pyrolysis, liquid metal infiltration, vapour techniques, and quick solidification were the most commonly used processing methods. Chemical systems, such as colloidal and sol-gel methods, as well as electrode position were employed to create metal matrix nano-composites [2].

3.2. Theory of nanocomposites

To a great extent, nanocomposite optical response theory is still constrained by Efficient mathematical models (e.g., the Maxwell Garnett (MG) model), which are focused on quasi-static approximation and can only be applied to low-volume fractions of inclusions, continue to constrain nanocomposite optical response theory to a large extent. Furthermore, the MG theory ignores the plasmon resonance's dependence on nanoparticle size and concentration. When large clusters of nanomaterials and their long-distance coupling significantly contribute to the optical properties near the percolation threshold, MG theory cannot provide a comprehensive view of the light-matter interaction [3].

In addition, the Bruggeman theory, which was commonly used for high concentrations of nanomaterials or nanovoids, was incorrect. Furthermore, the optical resonance positions were not predicted, nor were their relationship to nano inclusion concentration and properties. As a result, calculating the nonlinear and linear refractive index and absorption coefficient of nanocomposites has become increasingly dependent on numerical simulations, including machine learning approaches that require a massive amount of experimental trained data and are thus impractical. As a result, theoretical models and/or numerical performances capable of predicting the optical properties of nanocomposite materials were required, as well as the ability to bridge the gap between optical strategy and material construction [3].

3.3. The techniques used to process nanocomposites

Nylon-based nanocomposites were created in 2008 by first creating a polymer solution in an organic solvent, then adding clay nanoparticles, and finally vaporising the solvent. A batch of nylon-6 polymer/clay-based nanocomposite systems was created using the solution-induced intercalation technique. Al2O3 nanoparticles were suspended in a nickel-plating solution utilizing co-deposition. A high-speed plating technique, which was a cost-effective method for creating turbine blades for jet engines, was used to successfully integrate the nanomaterials into the metal matrix. Sheet-based nanocomposites were formed using Vacuum-Assisted Resin Transfer Molding (VARTM). The procedure involved injecting an appropriate resin into a vacuum bag containing pre-laid composite fabrics (in this case, fiberglass and carbon fiber materials) [4]. As shown in Table 2 below, some types of Nano-composites manufacturing techniques were compared.

Table 2. Summary of some types of Nano-composite manufacturing techniques [4]

Process nanocomposites	Brief description
Solution-induced intercalation	Polymer nanocomposites are suitable for investigating new functionalities that go beyond that conventional techniques. A solvent is used to create the matrix, and then nanoparticles are added before the solvent is removed.
Co-deposition	Nanoparticles were integrated into the matrix using high-speed plating.
Vacuum-Aided Resin Transferal Molding (VARTM)	Dispersion of composite fibre in a vacuum, such as carbon or glass fabric with the matrix.
Extrusion utilizing a single screw	The matrix and reinforcement are mixed at high temps. To produce a melt that is force-out as raw materials for other creation procedures including injection moulding.
Spraying coat method	Before being sprayed onto the substrate, nanoparticles, and matrix are combined.
Cross-Accumulation Roll Bonding (CARB)	The matrix and reinforcement are warmed first before plates are formed, cut, and formed a bond with rollers.
Compounding by melting	Introducing hot nanoparticles into the matrix.
Vibrational casting	Heat and vibration are combined to more excellently spread nanoparticles throughout the matrix.
Melt extrusion	Pellets of the matrix were combined with nanoparticles while being heated and wrapped around a rotating mandrel.
Dropping cast method	Epoxy systems and nanostructures were merged in a magnetic mixer before being cast drop by drop onto the slide glassing.

Powdering metal-working	Nano-elements were ball-milled and then inserted into the matrix.
Compression molding	While being heated and compressed, the matrix and particles were mixed using a melting process.
Stir casting	The matrix and reinforcement were thoroughly mixed while being continuously stirred before being dispensed into the prepared molding.
Induction heat sintering at high frequencies	After being compressed and heated, thermally exfoliated particles were sintered.
Thin-film fusion	The film was created using a modified Hummers technique and was adhered to a vacuum-bagged laminate.
Dip coating	The cleaned substrate is repeatedly dipped into the material solution, which is created by ultrasonically combining the particles and polymer until it is completely coated.
Pultrusion	After combining the matrix and nanoparticles, the raw material mixture was forced through a mold to take on the desired tube shape.
Ultrasonication	Excitation of the nanoparticle suspension setup.
Electrospray deposition (ESD)	A fabric that has been sprayed with a resin-nanoparticle mixture, followed by resin curing.

4. Discussion

Polymethyl methacrylate (PMMA) was a well-known plastic substance for denture applications due to its outstanding properties, such as ease of processing, lightweight, low cost, aesthetic properties, and oral stability. PMMA was however superior in terms of biomaterials, dependability, and the absence of taste, odour, and tissue irritation. Color, relative ease of manipulation, and an excellent visual appearance all contribute to a sense of security. PMMA-based materials were also preferred in a wide range of biomedical applications, including intraocular lenses and bone cement in orthopedics. In addition to removable dentures. PMMA is also used in interior design, clear dielectric film, clear glass substitutes, acrylic paints, and nanosized foams [4, 5]. However, PMMA has low strength, is brittle on impact, and has a low fatigue resistance. The PMMA denturing base formation is complicated and challenging, and stresses can be concentrated in frenum notches, leading to denture base cracks. Prosthodontic problems were primarily defined by 2 patterns: Firstly, biting and mastication forces, and secondly, high-impact forces that may occur as a result of an accident dropping, resulting in PMMA denturing fracture [5]. Denturing base impact failure caused by a fatigue fracture was a common clinical problem caused by their brittleness. Due to the importance of fracture resistance in a denture base resin, a variety of approaches to reinforcing PMMA resin dentures have been developed.

The much more important considerations for denture-based PMMA resins were adequate impact strength and fracture toughness. The primary disadvantage of the material when used alone was its poor mechanical strength. PMMA denture base materials were weak, with low impact strength and fatigue resistance [5]. To address these issues and improve the mechanical properties of PMMA denture bases, the inclusion of filler particles and rubber particles in the PMMA matrix material has indeed been proposed [5]. The main goal of this review was to take a gander at the use of nanocomposites in dental prosthesis restoration. PMMA denture resin, on the other hand, has poor surface characteristics and mechanical requirements such as flexural strength, hardness, fracture strength, and impact strength. As a result, to achieve a higher level of strength, PMMA acrylic must be strengthened. Many studies have been carried out to assess the expected benefits and applications of nanotechnology in dental applications. Polymeric nano-composites were composed of nanoscale fillers that were held together by a polymer matrix [6]. One of the most serious issues with PMMA was its technical properties. Previously, researchers discovered that nanoscale reinforcing agents could provide novel physical, mechanical, and biomedical properties, resulting in novel nanocomposites. PMMA had also been improved by grafting various nanoparticles. It had been reported that the dielectric properties of alumina nanofiller with PMMA blend nanostructure were affected [6]. The nature, surface morphology, and size of the nanoparticles all have an impact on the new composite properties. Nanomaterials outperform conventional materials in terms of physical properties such as density, but they lack mechanical properties. In response to the growing need to improve mechanical and physical properties, numerous research studies in the field of nanocomposites have been conducted [6]. PMMA acrylic resin reinforcement research was investigated. The modified composite properties, addition method, surface coating, bonding, and so on were then investigated.

The methodology, newly discovered composite properties, clinical success of the novel fabrication methods, and interaction with the PMMA polymer matrix have all been described [6]. Furthermore, Ceramic matrix composites (CMCs) were made up of one or more reinforcements embedded in a ceramic matrix, such as fibres, whiskers, nano-tubes, carbon nanotube (CNTs), particulates, and second polymers or metal phase [36]. Such composites, in general, had high strength and wear resistance, as well as excellent toughness, high-temperature stability, and thermal shock resistance. Because of their superior physical and mechanical properties, CMCs were in high demand for applications in the aerospace, automotive, energy and power, electronic parts and electrical items, and chemical and biomaterials engineering industries [36]. Nanoparticles embedded in an alloy matrix form [Metal Matrix Nano-composites] (MMNCs) [37]. The MMNC composites be made of a metal or metal alloy matrix and nanoparticles. This nanomaterial has a variety of applications in screen displays, electronics, equipment, storage devices, and so on due to its characteristics that differ from the host matrix. The properties of various nanoparticles differ. The properties of a particle change as its scale changes. Mechanical properties, damping characteristics, and good resistance can all be improved by incorporating these particles into the composite material [37].

5. Conclusion

Polymer nanocomposites are ideal for investigating new functionalities that go beyond what traditional materials can do. Nanocomposites were one of the most promising and rapidly developing areas of research. They were notable for their distinct advantages, such as lightweight, ease of manufacture, and flexibility. In comparison to conventional composites with small filler sizes, polymer nano-composites result in a massive increase in interfacial area. Even at low nanofiller loadings, the interfacial area generates a substantial volume fraction of interfacial polymer with properties distinct from bulk polymer. The interfacial structure of polymers containing high-surface area nanoparticles had been shown to differ from crystalline material, and despite the filler's small weight fraction, the majority of the polymeric materials were present near the filler.

Recommendation

1. A comparison of different polymer, metal, and ceramic materials, as well as different nanocomposites, and an investigation of all properties and their impact on mechanical and physical properties.
2. An evaluation of various nanocomposites' synthesis methods, as well as an investigation of all features and their effect on physical, biological, and mechanical properties.

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