

Nano in Prosthodontics



Medical Science

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ABSTRACT

Nanotechnology is a new branch of science, which is still at developing stage. This is actually a process of miniaturization and control of material at molecular stage, normally between 1 to 100 nanometer scale as well as fabrication of material at this scale. It is highly multidisciplinary field; covering fields of colloidal science, device physics, supramolecular chemistry. Two main approaches top down and bottom up. At nanostage materials show highly different property than they show in macroscale enabling unique applications. Dental materials manufactured by using nanotechnology has been used for prosthodontics namely nanocomposite, nanocomposite denture teeth, nanoadhesives, nanoimpression material, and nanodenture base material. Results are found to be encouraging. This article gives the scope and future of nano particles in dentistry.

NANO IN PROSTHODONTICS

INTRODUCTION

The word nano originates from the Greek word "dwarf". The concept of nanotechnology was first elaborated in 1959 by Richard Feynman, a Nobel Prize winning physicist, in a lecture titled, "There's plenty of room at the bottom". He ended the lecture concluding "this is a development which I think cannot be avoided" Since then, nanotechnology has found use in a myriad of applications including dental diagnosis, material and therapeutics. A day may soon come when nanodentistry will succeed in maintaining near-perfect oral health through the aid of nanorobotics, nanomaterials and biotechnology.²

WHAT IS NANOTECHNOLOGY

It means manufacturing of nanomaterials based on a nanometer scale. A nanometer scale is 10^{-9} or 1 billionth part of a meter or one millionth part of a millimeter or approximately one ten thousandth part of a human hair. It includes colloidal science, supramolecular chemistry and material science. Researchers observed that material reduced to nanoscale can suddenly show very different properties; for instance opaque substance becomes transparent, inert material becomes catalyst, stable materials becomes combustible, solid turns in to liquid at room temperature, insulators become conductors, materials which are chemically inert at normal scale when reduce to nanoscale can serve as potential catalyst; hence these qualities of nanoparticles enables unique applications. Nanoparticles (<100 nm in all 3 dimensions) have their unique size dependent and physicochemical properties.³

NANOTECHNOLOGY IN PROSTHODONTICS: -

Nanotechnology is being applied to various fields; Dentistry is no exception. In dentistry nanotechnology is applied to manufacture advance dental materials, which are used in the field of prosthodontics

Namely:-

- Nanocomposite universal restorative material
- Nanocomposite denture teeth
- Nano adhesives i.e. Bonding agents
- Nano-impression material.
- Nanodenture base material

IMPRESSION MATERIAL MANUFACTURED BY NANOTECHNOLOGY:-

In impression materials Nanofillers are integrated in vinylpoly siloxanes producing an unique addition siloxane impression material.

Advantages : Greater anatomical details were achieved after impression , Better flow, Fewer voids due to better hydrophilic

properties

Examples: - Nanotech elite h-d+, Imprint ii dental ++

Bonding agent:-

Adhesives incorporates 10% by weight of 5nm diameter spherical silica particles through a process that prevents agglomeration. Nanoparticles with their extremely small size keeps them in homogenous colloidal suspension

Advantages:-

Adhesives which contains large fillers has a tendency to settle out of the solution and require routine shaking of bottle before use consuming time whereas Nanoparticles are stable and do not cluster this makes the solution homogenous and particles don't settle out of dispersion. This property gives high dentine adherences and better performances

Examples:- Trade Name: - Adper O single bond 2

NANO-COMPOSITE

The increasing interest in esthetic restorations in recent years has led to further development of materials that have the same color as that of teeth⁴. The latest advance in composite resins is the implementation of nanoparticle technology into restorative materials.⁵ Nanotechnology has enabled the production of nano-dimensional filler particles⁶, which are added either singly or as nanoclusters into composite resins. Nanofillers are different from traditional fillers.^{7,8} When the filler for traditional composites is produced, large particles are minimized by pinning; however, these methods cannot reduce the size of a filler that is smaller than 100 nm.^{6,8} Nanotechnology allows the production of nano-sized filler particles that are compatible with dental composites; therefore, a greater amount of filler can be added into the composite resin matrix.⁶

Advantages:-

It shows that the compressive and diametric tensile strength were either equivalent or higher than those of the other composites tested. Flexural strength was measured to be either equivalent or higher than that of other composites. Fracture resistance was found to be either equivalent or higher than the other composites. Because of these properties; Nanocomposites are highly acceptable to the clinicians. wear rate is either statistically equivalent or lower than that of other composite materials. In addition to improve mechanical properties nanoparticles improve antimicrobial effect,³ inhibitory effect on MMP, no cytotoxicity on pulp tissue, dentin primer in AgNP.

examples: - Filtek supreme standard

Filtek supreme translucent

Filetek supreme standard:- it contain zirconia nanoclusters and silica nanoparticles with diameter 20nm

Filetek supreme translucent contains silica nanometric particle with diameter 75 nm and minor silica nanocluster

NANO-COMPOSITE DENTURE TEETH

Artificial teeth made of nanocomposite have also been produced. In these artificial teeth, inorganic fillers in nano-dimensions are diffused homogenously without any accumulation in the matrix. Therefore, the smoothness of the surface can be preserved even when the teeth are eroded. Tests have shown that nanocomposite artificial teeth are more durable than acrylic teeth and microfill composite teeth and have a higher resistance to abrasion⁹⁻¹². Moreover, composite resin artificial teeth containing nanofiller show superior color.¹³

Advantages

The nanocomposite denture teeth were found to be better wear resistant. Nanocomposite denture teeth possess unique characteristics in terms of homogeneity as the material contains nanosized inorganic fillers that are well dispersed without agglomeration in the matrix. Hence gives smooth appearance to the worn surfaces. Stain resistant and harder than other commercially present denture teeth.

DENTURE BASE MATERIAL

Researchers have developed polymer of the denture base material by nanotechnology. The non-agglomerated and non-aggregated and non-fumed silica particles of 200 nm diameters were taken. The surface of this nanosized particle was treated with silane. These particles were mixed with water and alcohol and then this dispersion was spray dried to get the nanosized filler particles. These filler particles were dispersed in either methacrylate or epoxy resin added with hardening substance like zirconium dioxide .

Advantages:-

Extremely dense material reduces the chance of breakage , Non porous surface greatly lessens odor causing plaque and bacteria, Comfortable because reduced irritation to the gums,Thin and light in weight , Natural looking as it allows patient's natural tissue to appear through the material.

Conclusion

Nanotechnology is a new branch of science, which is still at developing stage. This is actually a process of miniaturization and control of material at molecular stage, normally between 1 to 100 nanometer scale as well as fabrication of material at this scale. It is highly multidisciplinary field; covering fields of colloidal science, device physics, supramolecular chemistry. Two main approaches top down and bottom up. At nanostage materials show highly different property than they show in macroscale enabling unique applications. Dental materials manufactured by using nanotechnology has been used for prosthodontics namely nanocomposite, nanocomposite denture teeth, nano adhesives, nanoimpression material, and nanodenture base material. Results are found to be encouraging. Experiments have shown that these materials have low wear rate, better physical properties and translucency is more as light passes directly through very small sized particle. This property enables to manufacture variety of shades and opacity options.

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