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RESEARCH ARTICLE

NANOBIOMATERIAL.

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Abstract

Introduction:-

Dentistry is facing a major revolution in the wake of nanotechnology, having already been targeted by novel "nanomaterials".

Nanodentistry will make possible the maintenance of comprehensive oral health by employing nanomaterials, biotechnology, including tissue engineering, and ultimately dental nanorobotics.

Nanotechnology is still in the very early stages of research only becoming possible in the last century and is yet to be fully understood since many materials begin to act very differently on these nanoscales, often changing their properties in an unusual manner.

Within the **European Union**, the European Commission issued a Recommendation in October 2011, defining of nanomaterials as "**a natural, incidental or manufactured material containing particles, in an unbound state or as an aggregate or as an agglomerate and where, for 50% or more of the particles in the number size distribution, one or more external dimensions is in the size range 1nm-100nm.**"

Technology has improved a lot along with the complexity of devices .in the middle of the 20th century, a new technology was developed in various fields of sciences called microtechnology .in the ensuing progress at the beginning of the 21st century, a technological revolution occurred that began with the new developments in the technology of computers and the internet i.e. Science is undergoing yet another change in helping mankind to, enter in a new era' the era of nanotechnology.

Use In Dentistry:-

Nanotechnology has since coloured research & technological developments in engineering, basic sciences, medicine, dentistry & even social sciences. The trends in nano-scale research are getting brighter & expanding to

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such an extent that discussions in all branches of knowledge are heading towards nano-science & nanotechnology .the position of nanotechnology & its effect on all branches of science and life are very significant, particularly where the aim of such science is to change a situation that is not good or beneficial into something better.

There has been remarkable research on nanomaterials in recent years, which has moved it from theoretical foundation to clinical practice. Currently, there is a wide range of nanomaterial's applications in different subspecialties of dentistry. As a result of active research for developing new nano-products, the variety of available products for various dental applications is expected to increase remarkably in the near future.

Restorative Dentistry	Ketac™ (3M ESPE, St. Paul, MN, USA), Ketac N100; Nano-ionomers (3M ESPE), Filtek Supreme XT (3M ESPE), Fuji IX GP (GC, Leuven, Belgium), Nano-primer, Premise™ (Kerr/Sybron, Orange, CA, USA), Adper™ Single bond plus Adhesive (3M ESPE), Ceram X™ (DENTSPLY International, Milford, CT, USA).
Regenerative Dentistry and Tissue Engineering	Ostim® (Osartis GmbH, Elsenfeld, Germany), VITOSSO™ (Orthovita-Inc, Malvern, PA, USA), Nano-Bone® (ARTOSS, Rostock, Germany).

Endodontic	AH plus™ (DENTSPLY International), Epiphany (Pentron Clinical Technologies, Wallingford, CT, USA), Guttaflow® (Coltène, Altstätten, Switzerland).

History:-

In 1959 The first time, the vision of nanotechnology was introduced, when **Richard P Feynman**, a physicist at Caltech gave a talk called " **There's Plenty of Room at the Bottom.** He proposed employing machine tools to make smaller machine tools these are to be used in turn to make still smaller machine tools, and so on all the way down to the atomic level. He suggested that such nano-machine, nano-robots and nano-devices ultimately could be used to develop a wide range of atomically precise microscopic instrumentation and manufacturing tools. Feymen argued that these tools could be applied to produce vast quantities of ultra small computers and various microscale and nanoscale robots. He concluded that this is a development which i think cannot be avoided. Thus the vision of nanotechnology was born.

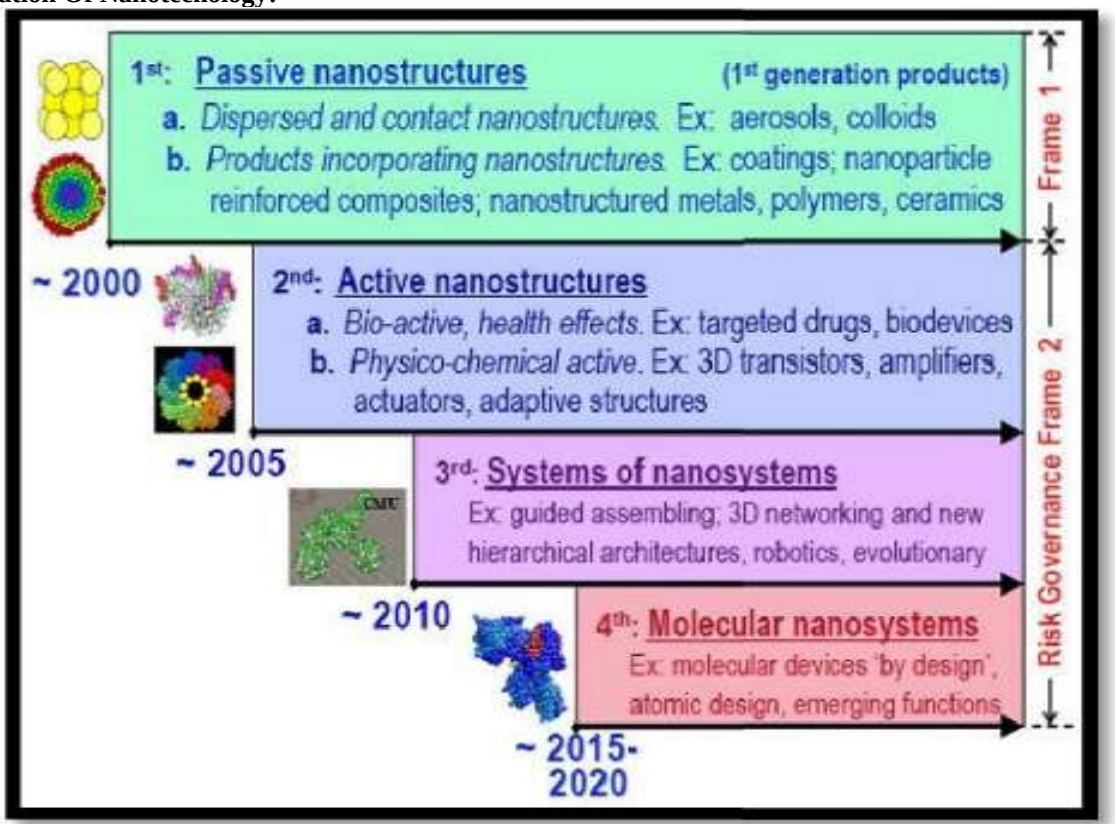
Literature Review:-

Freitas Jr. RA (2000) has described that nanodentistry will make possible the maintenance of comprehensive oral health by employing nanomaterials, tissue engineering and ultimately dental nanorobotics (nanomedicine). When the first minimum size dental nanorobots can be constructed in 10-20 years, these devices will allow precisely controlled oral analgesia, dentition replacement therapy using biologically autologous whole replacement teeth manufactured during a single office visit, and rapid nanometer-scale precision restorative dentistry. New treatment opportunities may include dentition re-naturalization, permanent hypersensitivity cure, complete orthodontic realignments during a single office visit, covalently-bonded diamondized enamel, and continuous oral health maintenance using mechanical dentifrobots.

Mitra S (2002) scientist 3M ESPE quotes at the introduction of first nanocomposite "when you consider that the wavelength of visible light is 400 to 800 nm we are dealing with materials 1 to 100 nm in size, it will be possible to create esthetic dental material indistinguishable from natural tooth structure by the human".

The nanocomposite is comprised of 2 fillers nanoparticles and nanocluster which range from 20-75nm and 0.02µm-0.075µ.m respectively. The combination of nanoparticles and nanoclusters allows for high filler loading thus exhibiting high strength of hybrid and polishability of microfills.

Generation Of Nanotecnology:-



Application Of Nanodentistry In Oral Diagnosis And Therapeutics

1. Photosenstizer and carriers:

Quantum dots can be used as a photosenstizer and carriers. They can bind the antibody to surface of target cell an when stimulated by ultraviolet light, they give rise to reactive oxygen species which are lethal to target cells.

2. Nanotherapeutics:

These are the highly specific and targeted drug delivery systems. Nanotechnology in field of therapeutics will help to solve the solubility problems, reduce the drug dosages and effective in treatment of brain disorders, Alzheimer's disease, Parkinson's disease etc.

3.Treatment of oral cancer:

Nanotechnology in field of cancer therapeutics has offered highly specific tools in the form of multifunctional Dendrimers and Nanoshells. The unique property of Dendrimers such as their high degree of branching, multi valence, globular structure and well defined molecular weight make them promising in cancer therapeutics.

Nanoshells are miniscule beads with metallic outer layers designed to produce intense heat by absorbing specific wavelengths of radiations that can be used for selective destruction of cancer cells leaving aside intact, adjacent normal cells.

Application Of Nanodentistry In Clinical Dentistry

1. Nanocomposites: Composite with nanofillers has two types of nanofillers - nanomeric and nanocluster type.

2. Nanoadhesives: They are nanosolutions which produce unique and dispersible nanoparticles which prevent agglomerations.

3 .Nano impression materials : Nanoimpressions are available with nanofillers integrated in the polyvinyl siloxane producing a unique addition siloxane impression materials. (Nano Tech Elite H-D+).

4. Dentifrices: They are nanosized hydroxyapatite crystals. These Dentifrices form a protective coating on tooth enamel and even restore the surfaces of damaged teeth. Some dentifrices also has microhydrin which consists of molecular cages, nanometer in diameter and degrade the organic food particles.
5. Materials to induce bone growth: Calcium sulphate is used to fill small voids such as those found in post extraction sockets and periodontal bone defects and as adjunct to the longer lasting bone graft materials. Dr Ricci has formulated new calcium sulphate based composite. Bone Gen -TR which resorbs more slowly and regenerates bone more consistently.
6. Orthodontic wires: Sandirk Nanoflex is a new stainless steel which allows ultra-high strength combined with good deformability, corrosion resistance and a good surface finish.
7. New electrochemical process for coating implants: Prof Noam Eliaz innovation found that the new implant to improves function and longevity. In this process there is electrochemical deposition of synthetic hydroxypatite over the implant surface.
These new implants are more acceptable to human body as these are able to enhance the integration of the nanocoatings to the human tissues. These nanocoatings very much resemble with the biological materials.
8. Bone replacement materials :
Hydroxyapatite nanoparticles used to treat bone defects are-
• Ostim (Osartis GmbH, Germany) HA,
• VITOSSO (Orthovita, Inc, USA)TM
• HA +TCP NanOSS (Angstrom Medica, USA) HA
9. Nano sterilizing solution: Gandly Enterprises Inc Florida has introduced a new disinfectant based on super science of nanoemulsion technology. It uses nanosized emulsifier droplets of oil that bombard the pathogens. **e.g. Eco Tru Disinfectant**

Advantages:
• Broad spectrum
• Hypo allergic
• Non corroding
• Does not stain fabric
• Require no protective clothing
• Environment friendly
• Compatible with various impression materials

Recent Advances Of Nanoparticles In Implant Dentistry
Dental implant therapy has been one of the most significant advances in dentistry in the past three decades. The success and longevity of dental implants are strongly governed by surface characteristics. Three factors have become key areas for improved implant device topography.

Nanoscale surfaces structuring, which would optimize cell colonization; surface chemistry, which attempts to control and optimize the chemical surface properties of an implant material; and wetability, due to the observation that cell adhesion and subsequent activity are generally better on hydrophilic surfaces. Structuring chemistry modification would require nanoscale processes while engineered nanomaterial would play a role in increasing wetability

Nanostructured biocompatible coatings-
Nanostructured hydroxyapatite coatings for implant have attracted attention during the last decade. Hydroxyapatite promotes bone formation around implant, increases osteo-blasts function such as adhesion proliferation and mineralization.
However, it is unlikely that bulk synthetic hydroxyapatite will be used as load bearing implants, since fracture toughness (~ 1.0 *m* Pa * *m*1/2) and flexural strengths (<140 *m Pa*) are low (Ogiso *et al.* 1996).

Nanostructure metalloceramic coatings are in the early stage of development. A nanocrystalline multi-layer (Cr/CrTi/CrTiN) coating was deposited on Co-Cr-Mo substrate. The Cr/CrTi metallic layer at the interface increases the adhesion to the Co-Cr substrate whereas Cr-Ti-N surface layer is covalent in nature, and enhances scratch resistance and wear of the coating.

Nanoporous ceramic implant coatings use a different approach to improve implant properties, i.e. annodisation of aluminum. This technique was used to create a nanoporous aluminum layer on top of titanium alloy implants. Nanoporous alumina has the potential of being rendered by loading the porous structure with appropriate bioactive agents improving cell response and facilitate osseo inductive activity.

Titanium and Titanium alloys are novels which have been successfully used as dental implants because these materials have good integration with adjacent bone surface without forming a fibrous tissue interface.

For the optimization of bone growth, surface treatment has been applied such as surface roughening by sand blasting, hydroxyapatite coating; formation of titanium dioxide or titania etc. Growth factors and biomolecules can also be immobilized onto implants to enhance growth and integration.

TiO_2 nanotubes produced by anodisation have been proposed as drug eluting coatings for implantable devices. The surface of the tubes can be functionalized to attach biomolecules, such as bovine serum albumin. Bone Morphogenic Protein (BMP) has been immobilized on the surface of Ti based implant to enhance bioactivity and bone formation.

The advantage of immobilizing BMP is that it allows controlled administration and avoids the problems associated with overdosing. Implants have been coated with nanocrystalline diamonds to increase the surface area and facilitate immobilization of BMP. The differentiation and proliferation of cells without changing the overall texture of the specimen can be achieved using these diamonds.

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