

Nanotechnology in Dentistry

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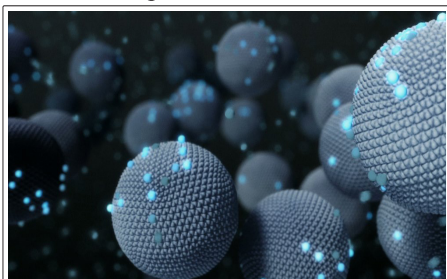
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Introduction

Nanotechnology (“nanotech”) is manipulation of matter on an atomic, molecular, and supramolecular scale.



Nanotechnology as defined by size is naturally very broad, including fields of science as diverse as surface science, organic chemistry, molecular biology, semiconductor physics, energy storage, microfabrication, molecular engineering, etc. The associated research and applications are equally diverse, ranging from extensions of conventional device physics to completely new approaches based upon molecular self-assembly, from developing new materials with dimensions on the nanoscale to direct control of matter on the atomic scale.

Scientists currently debate the future implications of nanotechnology. Nanotechnology may be able to create many new materials and devices with a vast range of applications, such as in nanomedicine, biomaterials energy production, and consumer products. On the other hand, nanotechnology raises many of the same issues as any new technology, including concerns about the toxicity and environmental impact of nanomaterials, and their potential effects on global economics, as well as speculation about various doomsday scenarios. These concerns have led to a debate among advocacy groups and governments on whether special regulation of nanotechnology is warranted.

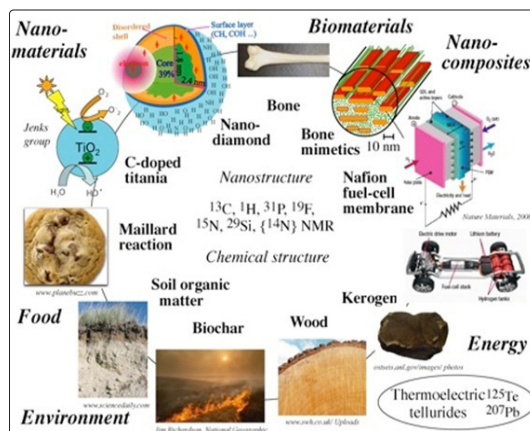


Nanotechnology is the science and engineering of small things, in particular things that are less than 100 nanometers in size (in one direction). Nano is an SI prefix and comes from the Greek word for dwarf - nanos. One nanometer is 10^{-9} meters or about 3 atoms long.



The late Nobel Prize winning physicist Richard P. Feynman in 1959 speculated the potential of nanosize devices as early as 1959. In his historic lecture in 1959, he concluded saying, “this is a development which I think cannot be avoided.”

There is a melange of applications of nanotechnology in the fields of dentistry. The applications of nanotechnology in dentistry have been increasing with time. Use of the latest technology related to nanorobotics and biotechnology it has become quite easy to attain a near-perfect oral health and hygiene.



Nanomaterials can be classified as zero-dimensional, one-dimensional, two-dimensional, and three-dimensional. The various nanostructures are

1. Nanopores
2. Nanotubes
3. Quantumdots
4. Nanoshells
5. Dendrimers

Application of Nano-Technology in Dentistry

Nano-Technology can be applied in various forms to improve the dental treatment and make it effortless to the dentist and convenient to the patient.

Some of the techniques where Nano-Technology can be applied to obtain a better outcome are as follows:

1. Dentifrobots (Nanorobotic Devices)

- a. Nanorobots in orthodontics
- b. Hypersensitivity cure
- c. Local Nanoanaesthesia
- d. Nano-Shells

2. Nano Materials Used in Dentistry

- a. Nano Composites
- b. Nano Solutions

1. Dentifrobots

Nanorobotics is the technology of creating machines or robots at or close to the microscopic scale of nanometres.

Nano robot is an artificial fabricated object able to freely diffuse into the human body and interact with specific cells at the molecular level by itself.

Usually, the Nano robots are composed of carbon as the principal element, and are equipped with on board Nano chips.

Nano robots work on the principle of surface antigens they identify different cell types by checking the surface antigens with the help of the sensors that are present on board. Once you have identified the target cell and reached the site, in our case when they reached the oral cavity they begin the activity that they were programmed to perform. For example, performing continuous calculus debridement, dislodge the plaque and microorganisms that cause caries etc.



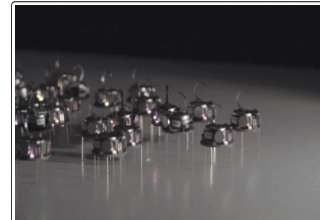
Fig-5 NANOROBOTIC ANESTHESIA
(courtesy-www.economist.com)

An arbitrary Nano robot consists of up power supply, a camera, legs that allow movement, and various other components based on the function that it is supposed to perform.

When the task of the Nano robots is completed they can be retrieved by allowing them to effuse themselves via the usual Human excretory channels or they can also be removed by active scavenger systems.

a. Nano Robots in Orthodontics

Nanorobotics centres on self-sufficient machines which are functional at the nanoscale. The Nano robot design consists of a biocompatible glycocalyx-coated material with molecular sorting rotors and a robot arm (telescoping manipulator). Different Nano robot molecule types are distinguished by a series of chemotactic sensors and their functioning is controlled by a stimulator.

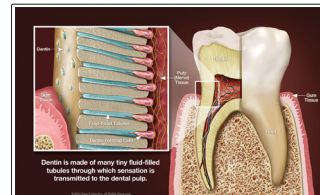


Nano robots may be used for manipulation of tissues directly at Nano level and research has begun on the use of nanorobotics for medical applications like drug delivery, management of aneurysms and tumours.

Orthodontic Nano robots could directly manipulate the periodontal, gingivae, periodontal ligament, cementum and alveolar bone, allowing rapid and painless tooth straightening, rotating and vertical repositioning within minutes to hours, in contrast to the current molar up righting techniques which requires weeks or months to complete.

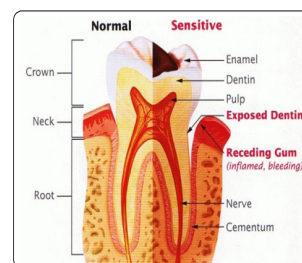
b. Hypersensitivity Cure

It is characterized by short, sharp pain arising from exposed dentin in response to stimuli typically thermal, evaporative, tactile, osmotic or chemical and which cannot be ascribed to any other form of dental defect or Pathology.



The most common clinical cause of dentin hypersensitivity is exposed dentinal tubules as a result of the gingival recession and subsequent loss of cementum on root surfaces.

Conventional treatment includes Fluoride, varnish, restorations, composite resins, calcium hydroxide paste, lasers etc.



Dentin hypersensitivity may be caused by changes in pressure transmitted hydro-dynamically to the pulp. This is based on the fact that hypersensitive teeth have 8 times the higher surface density of

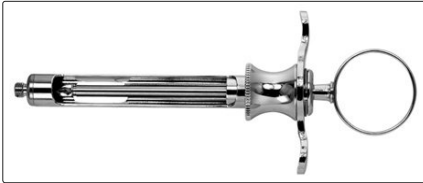
dentinal tubules and tubules with diameters twice as large as non-sensitive teeth.

Dental Nano robots can be used to selectively and precisely occlude selected dentinal tubules, offering patients a quick and permanent cure.

c. Local Anaesthesia Using Nano Technology

Introduction

The most commonly used local anaesthetic is lidocaine. Its half-life in the body is about 1.5-2 hours.



Injection usually makes patients apprehensive.

Using Nano Technology

A colloidal suspension containing millions of anaesthetic dental Nano robots would be used to induce local anaesthesia.

Deposited on the gingival tissue, the Nano robots would reach the dentin and move toward the pulp via the dentinal tubules, guided by chemical differentials, temperature gradients, and positional steering by a Nano computer under the control of the dentist.

On reaching the pulp, the analgesic robots may close down all sensation in the tooth.

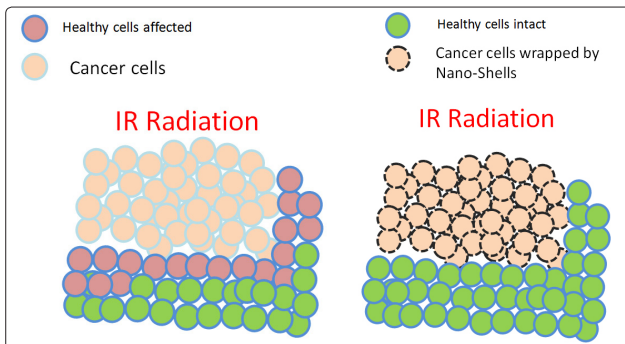
When the treatment procedure has been concluded, the Nano robots may be ordered to re-establish all sensations and to exit from the tooth. This technique is advantageous as it reduces apprehension and is fast and totally reversible.

Advantages of Using Nano Technology

1. Immediate recovery, whereas in the conventional method usually it lasts for 1 to 2 hours.
2. Needless delivery of anaesthesia.
3. No risk of complications occurring due to faulty technique.

d. Nano-Shells

The conventional method of Cancer therapy employs infrared radiation which is an invasive treatment and results in the damage of the healthy cells. This is the drawback of the conventional method of Cancer therapy, but when we do it using the nanotechnology i.e. the Nano shells radiation can be focused only on the affected cells.



The Nano shells especially designed to identify and attach to be cancerous cells, the material used in making Nano shells is selected in such a way that it has a property of absorbing infrared light. The Nano cells when injected into an individual affected with cancer identify the target cells i.e. cancerous cells and get attached to them. With the help of the Nano shells attached to the cancerous cells radiation therapy can be carried out with minimal damage to the healthy cells.

2. Nano Materials Used in Dentistry

a. Nano Composites

These are the composite materials enriched with Nano filler particles, as a result the material has superior qualities compared to the conventional composite material.

Some of the advantages of Nano composites over the conventional composites are as follows:

- 50% reduction in filling shrinkage
- Superior flexural strength, modulus of elasticity and translucency
- Excellent handling properties
- Superior hardness
- High polish retention
- Higher translucency giving it more lifelike appearance



Trade Name: Filtek O Supreme Universal Restorative P Lire Nano O

b. Nano Solutions

Nano solutions are constituted by dispersible nanoparticles, which are then used as a component in bonding agents. They lead to homogenous and perfectly mixed adhesive consistently.

Advantages

- Higher dentine and enamel bond strength
- High stress absorption
- Longer shelf life
- Durable marginal seal
- No separate etching required
- Fluoride release



Trade Name: Adper Single Bond Plus Adhesive Single Bond

This is a fast, easy and convenient single-component bonding agent offering exceptional bond strength and unique, easy dispensing bottle. Benefits include excellent shear bond strength provides exceptional bonding performance. Nano filler is stable and will not settle out of dispersion. Unique, easy-dispensing bottle permits visual inspection of exactly how much adhesive remains in the bottle. Cap snaps securely shut minimizing evaporation. No shaking required - use straight out of the vial. Ethanol/water-based adhesive maintains its shear bond strength over time to yield an outstanding shelf life.

Challenges Faced by Nano Dentistry

Precise positioning and assembly of molecular scale part.

- Making the Nano Technology Economical and inexpensive
- Biocompatibility
- Simultaneous coordination of activities of large numbers of independent micron-scale robots
- Social issues of public acceptance, ethics, regulation and human safety

Problems for Research in Nanotechnology in India

Painfully slow strategic decisions

- No proper Funding
- Needs more engagement
- Problem of retention of trained manpower

Conclusion

We can say that Nano-Technology has the potential to make treatment and diagnostic procedures effortless for the operator and convenient for the patient. Involvement of Government and private industries and their collective research is crucial for the development, growth and expansion of the potential of Nano-technology [1-10].

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