

# NANOROBOTICS IN DENTISTRY

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## ABSTRACT

*Nanorobotics is the technology of creating machines or robots at or close to the microscopic scale of a nanometer (10<sup>-9</sup> m). More specifically, nanorobotics refers to the hypothetical nanotechnology engineering discipline of designing and building nanorobots; devices ranging in size from 0.1 to 10  $\mu$ m and constructed of nanoscale or molecular components. With the modern scientific capabilities, it helps the engineer to attempt the creation of nanorobotic devices which interface them with the macro world for controlling purpose. There are many such machines which exist in nature. There is an opportunity to building more of them by this nature. With the help of these nanorobots, we can treat various types of incurable diseases. Their first useful application was in medicine to identify and destroy cancer cells but the most interesting applications may be in dentistry. The present article aims to provide an early glimpse on the impact and future implication of nanorobotics in dentistry.*

*Keywords: Nanorobotics, Dental practice, Nanomedicine, Nanotechnology*

## INTRODUCTION

Nanotechnology is the science of manipulating matter, which was measured in billionth of meters or in manometers, which will be of size 2 or 3 atoms. "Nano" is a Greek word which means "dwarf". Approximately, its width can be one ten thousand of human hair. In other words, it is engineering at the materials of atomic or molecular scale.

Nanotechnology is an emerging field, which deals right from conventional physics to present concepts molecular self assembly. Nanotechnology is concept on creating and developing new materials and machines with nano dimensions. The application of nanotechnology in the field of dentistry involves the maintenance of oral health by the use of nanomaterials, in the field of biotechnology and also in dental nanorobotics.

## NANOROBOTS: WHAT ARE THEY?

Nanorobots are the theoretical and microscopic devices, which is measured nanometers where 1 nm = one millionth of 1 mm. Nanorobots work at the atomic, cellular and molecular level to perform major tasks in the field of medical and industrial fields. Nanorobots, used in the medicinal field are so tiny which can easily traverse through human body. Scientist says that the structures of a nanorobot are constructed with the carbon atoms which of diamondoid

structure because of its inert properties. Glucose and natural body sugars, oxygen are the source for making propulsion and the nanorobot includes other biochemical parts and molecular parts based on its task.

Nanomachines are mainly in the research developing phase, but some primary molecular machines are already tested. Considering an example of a sensor having a switch about 1.5 nm across, this is capable of counting specific molecules in a chemical sample. Another main and important application is detecting of toxic chemicals, and their concentration level in the surroundings.

## **ELEMENTS AND MECHANISM OF ACTION ON NANOROBOTS**

Nanorobots in the field of medicine are used for the purpose of protecting and maintaining the human body against the pathogens. They are of size 0.5–3  $\mu$ m in diameter which are constructed with many parts which are in dimensions of range of 1–100 nm. The main elements used in constructing nanorobots are carbons which are of form diamond due to its increasing strength and its chemical inertness. Other lighter elements such as oxygen, nitrogen are used for performing special purposes. The external diamond coating provides a smoothness, flawless coating which evokes less reaction from the human immune system.

The nanorobots are powered by metabolizing oxygen, local glucose and some externally supplied acoustic energy. They are controlled by some on-board computers which are capable of performing 1000 or more computations per second. Communication between the device can be achieved by using broadcast type acoustic signaling method. Navigational networks which are installed in the body, provides degree of higher accuracy to all passing nanorobots that helps in keeping track of the different devices in the human body. Nanorobots are able to differentiate different types of cells by examining their surface antigens. Constructing nanorobots includes control, actuators, sensor, communication, power and interfacial signals across spatial scales and between organic and inorganic as well as biotic and abiotic systems. Nanoactuators are controlled by electrical or light signals. Once the task is completed, the nanorobots retrieved by allowing them to exfuse themselves through the human excretory channels. They can also be removed by using active scavenger systems.

## **TWO PERSPECTIVES OF APPROACHING NANODENTISTRY**

In Nanodentistry, there are two types of approaches as follows:

1. Building up of particles by combining their atomic elements, that is, bottom up approach.
2. Nanoscale objects are created by using equipments, that is, top down approach.

## NANOROBOTICS IN DENTISTRY

The enhancing interest in the field of dental applications of nanotechnology is leading a new developing field called nanodentistry. Nanorobots are used in treatment of, desensitize tooth, oral analgesia, and multiply the tissue to straighten and re-align irregular set of teeth and to improve durability of teeth. Further nanorobots are used to do prevent, restore & cure procedures.

Nanorobots might use special moving mechanisms to travel through human tissues with navigational precision. They will receive energy and sense to manipulate its surroundings. These nanorobotic functions are controlled by an on-board nanocomputer which executes pre-programmed instructions in reference to local nanorobots through acoustic signals or some other means.

### VARIOUS POSSIBLE USES OF NANOROBOTS IN DENTISTRY ARE

#### ➤ Major tooth repair

Nanodental techniques include tissue engineering, genetic engineering, tissue regeneration procedures for major tooth repair. Main function of nanorobotics is to manufacture and install biologically autologous whole replacement tooth that includes both mineral and cellular components which leads to complete dentition replacement therapy.

#### ➤ Tooth durability and appearance

Nanodentistry has provides material which is the nano-structured composite material, called as sapphire which increases both tooth durability and appearance. Upper enamel layers have been replaced by covalently bonded artificial material such as sapphire. Like enamel, sapphire is a asusceptible to acid corrosion. Sapphire is known for its best standard whitening sealant and cosmetic alternative.

### MAINTENANCE OF ORAL HYGIENE

A mouthwash of complete smart nanorobots will detect and destroy pathogenic bacteria but allows the harmless flora of the mouth to flourish in a healthy environment.

Further the devices would detect particles of food, tartar or plaque and removed from teeth by rinsing. They can swim and suspend in liquid , so that , devices would be able to reach interior surfaces. They protect tooth from decay and provide a continuous barrier to halitosis.

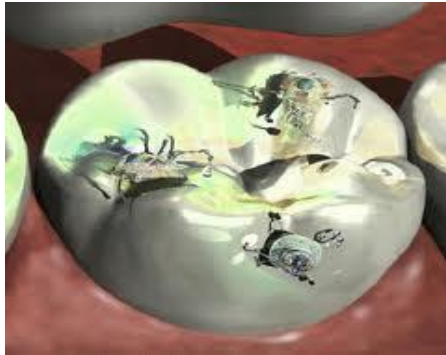


Figure 1: nanorobots in dental treatment

#### ➤ **Cavity preparation and restoration**

Multiple nanorobots that work on the teeth in unison, which is invisible to the naked eye, are used for cavity preparation and also for restoration of teeth. The cavity preparation is very deeply restricted to the demineralized enamel and dentin, thus it provides maximum conservation of tooth structure.

#### ➤ **Dentin hypersensitivity**

Dentin hypersensitivity is a one of the pathological phenomenon due to changes in pressure, which is transmitted hydro dynamically to the pulp. This is based on the fact that hypersensitive teeth are eight times higher surface density of dentinal tubules and also tubules with diameters twice as large as non-sensitive teeth. Reconstructive dental nanorobots are selectively and precisely exclude specific dentinal tubules in a minute, using some native biologic materials, which offers a patient from quick and permanent cure from hypersensitivity.

### **DIAGNOSIS AND TREATMENT OF ORAL CANCER**

Nano electromechanical system (NEMS) is an ultrasensitive mass detection technology converts biochemical to electrical signal and cantilever array sensor which are used for the detection of 10–12 bacteria, DNA and viruses. These are widely useful in the treating diabetes mellitus, oral cancer, and for detecting bacteria, viruses etc.

Nanomaterials are made up of branchy therapy like “BrachySil” (Sivida, Boston & Perth, Australia) which deliver 32P, that is in clinical trial. Drug delivery system crosses the blood brain barrier is the future aim this technology. Alzheimer disease, Parkinson disease, brain tumours will be managed efficiently. Nanovectors for gene therapy are also developing stage to correct disease at molecular aspect.

➤ **Targeted cellular destruction**

Quantum dots are used as photo-sensitizers that can mediate through targeted cells for destruction. They are able to bind antibody that is present on surface of target cell and then when stimulated by UV light, it will release some reactive oxygen species which are lethal to target cell. This therapy is an efficient way to fight with malignant cells

By using quantum dot nanoparticles, intraoperative imaging malignant lesion by fluorescence nanoparticles and targeted malignant cell destructed.

Nanoparticles play a major role in developing new technology for identifying cancer. The early stage detecting cancer is a critical step in improving cancer treatment. Various nanoparticles used are quantum dot, nanotubes, cantilever and nanopore.

As cancer cells secrete its molecular products, the antibodies that is coated on the cantilever fingers would selectively bind to the secreted proteins. The properties of the cantilever are that, it change in real time and provides some information about the presence and concentration of different molecular expressions. It includes nanocantilevers made by single crystal silicon, which is an etched nanometer reading scale. A light microscope is used to read cantilever deflection with reading scale.

Another amazing nanodevice is nanopore. This improved methods of reading genetic code helps researchers in detecting errors in genes which may contribute to cancer. Nanopores consist of tiny hole that allows DNA to pass through one stand at a time, which makes DNA sequencing more efficient.

Nanotubes-carbon rods are about half the diameter of a DNA molecule that, not only detect the presence of altered genes but also pinpoint the exact location of changes. A extraordinary team at the Massachusetts institute of technology (MIT) has developed some carbon nanotubes that can be used as sensors for cancer drugs and DNA damaging agents inside the living cells. Carbon nanotubes would fluoresce near infrared light which takes advantage whereas human tissue would not. This interaction between DNA and the DNA disruptor changes the intensity or wavelength of the fluorescent light which is emitted by nanotubes.

**Treatment of oral cancer:**

Most common use of nanoshells dendrimer and dendrimer nanoparticles will facilitate drug delivery. A molecule carried by single dendrimer recognizes cancer cell, and therapeutic agent to kill those cells, and recognizes the signal of cell death. Dendrimer nanoparticles have become promising drug delivery vehicles that are capable of targeting tumors with large doses of anti-cancer drugs. Nanoshells contains core of silica and a metallic outer layer. By increasing the thickness of the layer, scientist can able to design beads to absorb near infrared

light, in turn creating an intense heat that is harm to cancer cells. The selectivity to cancer lesion site occurs through enhanced permeation retention (PR).

## NANOTECHNOLOGY AND CANCER

Nanotechnology is more popular areas in scientific research, in the part of medical applications. We discussed some of the new detection methods which help to bring about faster cheaper and less invasive cancer diagnoses. While diagnosing cancer, there's is a prospect of surgery or radiation treatment to destroy the cancer. Unfortunately, these treatments carry some serious side effects. Chemotherapy would cause a variety of ailments, digestive problems, including hair loss nausea, mouth ulcers and lack of energy.

A nanotechnologist says that they have an answer for treatment, and it comes in the form of targeted drug therapies. If scientists load the cancer-detecting gold nanoparticles with anticancer drugs, they would attack the cancer exactly where it lives. Such a treatment means less side effects and less medication used. Nan particles can carry the potential for targeted and time-release drugs. A potent dose of drugs should be delivered to a specific area but engineered to release over a planned period to ensure maximum effectiveness.

The main aim of these treatments to take advantage of nanotechnology and the various tendencies of cancer cells, which depends on everything, including drug-laden nanoparticles. One experiment of these type used modified bacteria cells they were 20 percent of size of normal cells size. These cells were equipped with antibodies that they are latched onto cancer cells before releasing the anticancer drugs they contained.

It may be sound like odd, but the dye in your blue jeans or your ballpoint pen has also been paired with gold nanoparticles to fight cancer. This dye, called as phthalocyanine, which reacts with light. The nanoparticles take the dye directly to cancer cells, but normal cells reject the dye. When the particles are present inside, scientists "activate" them with light to destroy the cancer. Some therapies have existed to treat skin cancers with light-activated dye while scientists are now working to use nanoparticles and dye to treat tumors deep in the body.

Scientist manufacturing the medicine for many types of scientific research, nanoparticles is now common, but some scientists have voiced concerns about their negative health effects. Nanoparticles which are small in size allow them to infiltrate almost anywhere. That's great for cancer treatment as well as potentially harmful to questions about how healthy cells and DNA. They are also using the dispose of nanoparticles in manufacturing or other processes. Special disposal techniques are must be prevent harmful particles from ending up in the water supply or in the general environment, where they are impossible to track.



Gold nanoparticles one of the most choice for diagnostic testing, medical research and cancer treatment, but there are many types of nanoparticles in use as well as in development.

In other words, scientists are so combined up in what they can do; they're not asking if they should do it. The Food and Drug Administration have a task force on nanotechnology, but the government has exerted little regulation.

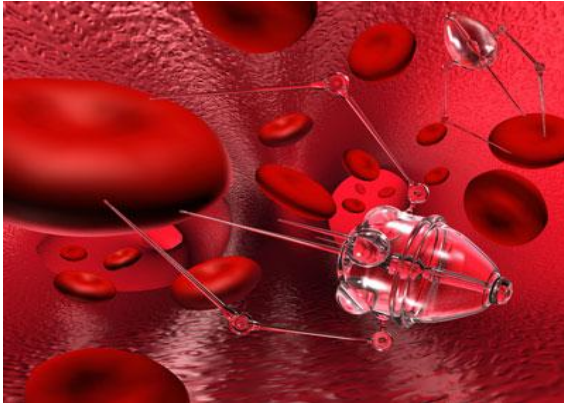


Figure 2: nanorobots in cancer treatment

## CONCLUSION

All these current developments in technology direct a step closer to nanorobots, in the way as simple operating tools in the near future. As Dr. H. G Wells rightly quoted “What on earth would man do with himself if something did not stand in his way?” Dr. Gregory Fay described “nanorobots as living organisms, that is naturally existing in fabulously complex systems of molecular nanotechnology”.

Nanorobots would change health care, dentistry and human life more profoundly other than the developments. Even though research into nanorobots is still in its starting stages, the promise of such technology is never end. Nanorobots applied to dentistry that holds a promise for treating disease in a peaceful manner.

By emerging all the technologies, a successful future for nanotechnology would be achieved through open sharing of ideas and research finding, through testing and frank discussion.

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