

NANO "BUSTERS" (PART-I)

DR. SANJYOT MULAY; DR. DOLLY RATHOD

ABSTRACT

Science is the fuel for the engine of technology. Today the revolutionary development of nanotechnology has become the most highly energized discipline in science and technology. The growing interest applications of nanotechnology is leading to emergence of a new field called nanomedicine (including nanodentistry).¹

Nanodentistry will make possible of comprehensive oral health care by involving the use of nanomaterials, biotechnology and ultimately dental nanorobotics. Nanodentistry is a new trend of oral health that has its application in preventive intervention, curative and restorative procedures. This paper highlights the potential application of nanotechnology in dentistry.

INTRODUCTION

Nanotechnology is engineering of molecularly precise structures. These are the molecular machines of typically 0.1micromillimeter (nm) or smaller than that. "Nano" is derived from the Greek word for "dwarf". The prefix "Nano" means ten to the minus ninth power 10^{-9} , or one billionth. The nanoscale is about a thousand times smaller than micro, which is about 1/80,000 of the diameter of a human hair. The growing interest in the future of dental applications of nanotechnology is leading to the emergence of a new field called Nanodentistry.²

DEFINITION OF NANOTECHNOLOGY

- Wikipedia's defined Nanotechnology as "A field of science whose goal is to control individual atoms and molecules to create computer chips and other devices that are thousands of times smaller than current technologies permit".
- Merriam-Webster's collegiate Dictionary defined Nanotechnology as "The art of

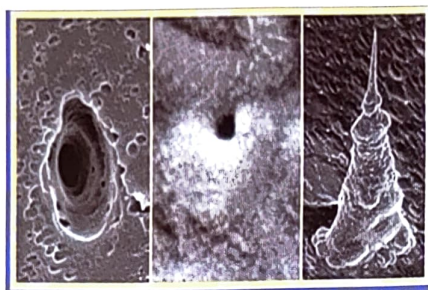


FIG 1: Nanopores

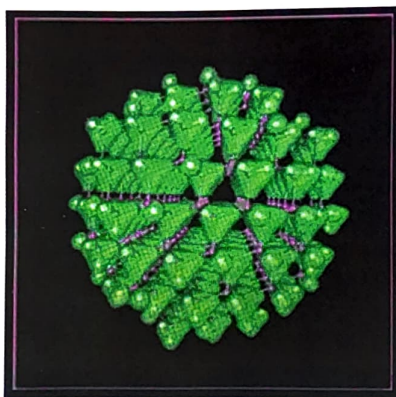


FIG 3: Quantum Dots

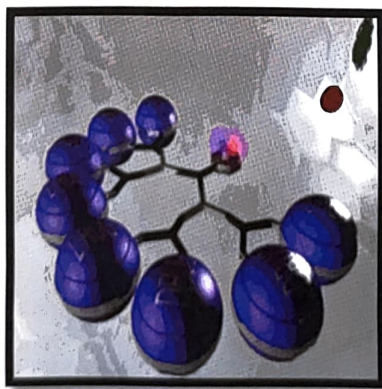


FIG 5: Dendrimers

manipulating on an atomic or molecular scale especially to build microscopic devices /robots".

PIONEERS

The late Nobel prize winning physicist

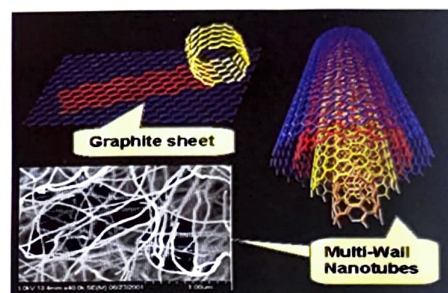


FIG 2: Nanotubes

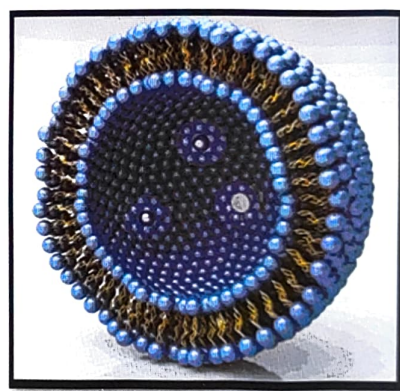


FIG 4: Nanoshells

Richard P. Feynman in speculated the potential of nanosize devices as early as 1959. In his historic lecture in 1959, he concluded saying "This development which I think cannot be avoided" He proposed using machine tools to make smaller machine tools, which in turn, would be used to make still smaller machine, tools and so on all the way down to the molecular levels. He suggested that such nanomachines, nanorobots and nanodevices could ultimately be used to develop a wide range of atomically precise microscopic instrumentation and manufacturing tools. These tools could be applied to produce vast quantities of ultra small computers and various micro scale and nanoscale robots. Thus vision of nanotechnology & their application in medicine and dentistry was born.

Nanotechnology aims to manipulate and control particle to create novel structures with unique properties and promises advances in medicine and dentistry.³

NANO- MANUFACTURING PROCESS

There are two basic approaches for creating Nano devices. Scientists refer to these methods as-

- A. The top-down approach
- B. The bottom-up approach

The top-down approach

It involves molding or etching materials into smaller components. This approach has traditionally been used in making parts for computers and electronics.

The bottom-up approach

It involves assembling structures atom-by-atom or molecule-by-molecule, and may prove useful in manufacturing devices used in medicine.

Various nanostructures are:⁷ [Fig no: 1]

- 1) Nanopores
- 2) Nanotubes
- 3) Quantum dots
- 4) Nanoshells
- 5) Dendrimers

Nanopores

Scientists believe Nanopores, tiny holes that allow DNA to pass through one strand at a time, will make DNA sequencing more efficient. As DNA passes through a nanopore, scientists can monitor the shape and electrical properties of each base, or letter, on the strand

Nanotubes

Nanotubes are carbon rods about half the diameter of a molecule of DNA that not only can detect the presence of altered genes, but also may help researchers pinpoint the exact location of those changes.

Quantum dots

Quantum dots are tiny crystals that glow when they are stimulated by ultraviolet light. The wavelength, or color, of the light depends on the size of the crystal. Latex beads filled with these crystals can be designed to bind to specific DNA sequences. When the quantum dots are

stimulated with light, they emit their unique bar codes, or labels, making the critical, cancer-associated DNA sequences visible, eliminating the need for biopsy.

Nanoshells

Nanoshells are miniscule beads coated with gold. By manipulating the thickness of the layers making up the Nanoshells, scientists can design these beads to absorb specific wavelengths of light. The most useful Nanoshells are those that absorb near-infrared light, which can easily penetrate several centimeters of human tissue. The absorption of light by the Nanoshells creates an intense heat that is lethal to cells.

Dendrimers

Dendrimers are man-made molecules about the size of an average protein, and have a branching shape. This shape gives them large surface area to which scientists can attach therapeutic agents or other biologically active molecules. Researchers eventually aim to create nanodevices that do much more than deliver treatment.

NANOTECHNOLOGY IN DENTAL SCIENCES

Application of nanodentistry can be categorized as:

Nanodentistry as top-down approach

1. Nano aluminium oxide fibers-nanoceram³
2. Salivary diagnostics powered by nanotechnologies
3. Nanoneedles
4. Nanobone replacement materials
5. Nanotechnology for dental composites
6. Nanotechnology for glass ionomer cement
7. Nano-Ceramic technology
8. Nanotechnology for impression material

Nanodentistry as bottom-up approach

1. Inducing anesthesia
2. Treatment of hypersensitivity
3. Tooth repair

4. Nanorobotic Dentrifrice (dentifrobots)
5. Orthodontic nanorobots
6. Diagnosis & Treatment of oral cancer
7. Photosensitizers and carriers
8. Dental durability and cosmetics

Nanotechnology applied to dentistry in-

- A) Diagnostic science
- B) Preventive dentistry
- C) Dental materials sciences
- D) Dental surgical procedures
- E) Endodontics

DIAGNOSTIC SCIENCE

- 1) Diagnosis of oral cancer
- 2) Treatment of oral cancer

PREVENTIVE DENTISTRY:

- 1) Dental hypersensitivity
Tooth repair
- 2) Nanox (Toothbrush with Tooth paste)

DR. SANJYOT MULAY (Prof &HOD),
Department of Conservative &
Endodontics; Dr. D.Y. Patil Dental College,
Pune, Pimpri-18; Maharashtra (India).

DR. DOLLY RATHOD
(IInd Post Graduate Student)
Department of Conservative &
Endodontics; Dr. D.Y. Patil Dental College,
Pune, Pimpri-18; Maharashtra (India).