

REVIEW ARTICLE**NANOTECHNOLOGY IN DENTISTRY: A REVIEW**Chintan Raval¹, Komal Vyas², Unnati Gandhi¹, Bhooshir Patel³, Pinal Patel⁴¹B.D.S., Karnavati School Of Dentistry, Ahmedabad, ²B.D.S., College of Dental Science and Research Centre, Ahmedabad, ³B.D.S., Narsinhbhai Patel Dental College, Visnagar, ⁴B.D.S., Faculty of Dental Sciences DDU, Nadiad**ABSTRACT:**

In the current era of 21st century, it has become imperative to invent newer techniques in the field of dental diagnosis and subsequent treatment plans. Ever since the understanding of the dimensions of the nanotechnology, it has been suggested that it is the most important area of breakthrough considering its reverberation in the field of medical science. With variegated uses in the sub fields of drug manufacturing, drug administration and other materials, a whole new horizon is available in the form of nanotechnology. The article reviews various prospective aspects of the nanotechnology in dentistry.

Keywords: Nanotechnology; Nanopores; Nanomaterials.

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This article may be cited as: Raval C, Vyas K, Gandhi U, Patel B, Patel P. Nanotechnology in Dentistry: A Review. J Adv Med Dent Sci Res 2016;4(3):51-53.

INTRODUCTION:

The chief cardinal goal in the field of dentistry is to provide optimum oral health care to the patients in the form of considerate diagnosis and management. The goal can be achieved by the availability of skilled dental professionals and auxiliaries along with the help of propitious material and equipment. With the alleviation of facile instruments, flawless treatment with better results can be attained. This has been possible only to a certain limit, pertaining to the lack of availability of advanced technology. Nanotechnology, perhaps, provides an opportunity to explore a coherent technology beneficial to the field of medical science.

Nanotechnology is a terminology procured from a Greek locution called “Nanos” which is insinuated as a dwarf. Mr. Richard Feynman, who has earned a Nobel Award for Physics, in the late 1950’s addressed an oration describing the possibility that perhaps the particles could be exploited at the most basic molecular level as per our desire.¹ He believed it could be done at the billionth of meter. However, the exertion of the terminology “Nano-Technology” was primarily formulated by a scientist in Japan called Dr. Nori Taniguchi in the mid 1970’s. He went on to describe nanotechnology as the process of detachment, combination and deformation of any distinct material

with the help of an atom or molecule.² Reviving the ideology of Mr. Feynman in the late 1980’s, a book was written and published by the Mr. Eric Drexler which played a vital role in popularizing the possibilities associated with the ideology of nanotechnology.³

One cannot argue at the fact that in spite of all the advances in the field of dental science, we still lack the availability of ideal equipment and materials.⁴ With the enhanced understanding of nanotechnology at such a core level will provide evolution of better products which would be ideal in the years to come. Presently, nanotechnology is employed in varied portions of the dental medicine.⁵ The commonly used materials with inputs of nanotechnology are listed in Table 1.

TABLE 1: Application of Nanotechnology in dentistry with available products⁶

Branch	Materials
Oral Implantology	Nanotite-An implant
Regenerative Dentistry	Ostim, Vlitosso, Nano-Bone
Orthodontics	KetaC-N100 Light Curing Nano-Ionomers
Periodontics	Arestin, Nanogen
Preventive Dentistry	Nano-Care Gold
Prosthodontics	Nanotechnology elite HD plus
Endodontic	AH plus, Epiphany

Nanotechnology in Diagnosis: With the availability of nanotechnology, it would be less arduous for the dental professionals to carry out a test in a simplistic and sensitive manner. This would also lead to a significant decline in the cost of the procedure as well as save time. Nano-materials that could be of help are as follows:

- 1) **Cantilevers:** Nano-Cantilevers have been developed as a belittled silicon strip which have extremely small rods that bind to the carcinogenic molecules or proteins. It has been demonstrated to be able to perceive even a small attogram. They are a source of potential flexible boards to be used in future due to its unique property to detect vibrations at variegated frequencies. It would form a part of most advanced lithographic sensors allowing to detect almost any pathogen.
- 2) **Nano-pores:** Nano-pores can be described as a miniscule hole in a very thin membrane. They would only sanction the transit of a single strand of DNA. Nanopores will be contrived from living organisms or could be completed manufactured in a new form by use of nanotechnology. Their utilization in the field of diagnostics could be based on their ability as a substantial sensor. They are looked up as the most possible powerful sensors for carcinogens in future.
- 3) **Nanowires:** With advantages like enhanced selectivity and rapid response, nano-wires are powerful in the form of detecting sensors for proteins and other molecules. It works on the principle of detecting variation in the electric field which helps it notice other molecules.

Nanotechnology in Prevention: Nanotechnology in the prevention of dental disease could play avital role in the form of better toothbrushes and toothpastes.

- 1) **Nano-Toothbrush:** A concept is in the developmental stages which suggests that if there is use of colloidal gold or colloidal silver between the bristles of the toothbrush, it could lead to tremendous decline or prevention of gingival inflammation as well periodontitis. Silver has significant affinity towards negative molecules like phosphates which helps them disrupt cell wall functioning leading to the removal of microbial plaque or bio-film.⁷
- 2) **Nano-Toothpastes:** It is highly exigent to thrive for an exorbitant quality of the toothpaste to improve the effectiveness of the oral health care. Nanotechnology in the form of nano-toothpastes seems to be an effective option. The agglomeration of the bacterial molecules in the porosities of the

hydroxyapatite crystals is due to the porosity of the enamel prisms.⁸ The nano-toothpaste would be effective to close the porosities and help in improving the shade of the tooth color. Currently, nanoparticles in the form of whitening agent is used as titanium oxide in the toothpastes.⁹

Nanotechnology in Treatment:

- 1) **Antimicrobial Effect:** Various nanoparticles in the form of silver, zinc oxide, ammonia, gold and carbon have an effective antimicrobial action using variegated mechanism of actions.

TABLE 2: Nano-particles & their antimicrobial activity with the proposed action

PARTICLE	ACTION
Silver	Silver Ag ions are responsible for disrupting cell membranes and repairing a damage in genetic structure ¹⁰
Zinc oxide	Zinc Oxide Ions are responsible for disrupting cell membranes and initiation of H2O2 Release ¹¹
Ammonia	Ammonia causes disruption of cell wall by penetrating it ¹²
Gold	Gold has an effective electrostatic potential ¹³
Carbon	Carbon oxidizes the constituents of the membrane thus causing disruption ¹⁴

- 2) **Effective delivery system:** A major difficulty in current medicine, is the effective delivery system. This can be overruled by the use of appropriate delivery systems.

- A) **Nano-Capsules:** One of the major breakthroughs in the branch of dental science is the availability of the nano-capsules. Nano-capsules have been implicated in the providence of drugs by forming a shell like structure. Moreover, the nano-capsules can be controlled to be released at a specific location at a controlled rate.¹⁵
- B) **Nano-scaffolds:** Utility of nano-scaffold was first carried out for the thrust of hormone delivery. However, the usage can be extended to target any specific location in the body for effective delivery of any drug. In dental medicine, uses includes regeneration of various tissues in the oral cavity including PDL and alveolar bone.¹⁶
- C) **Nano-Quantum Dots:** Quantum dots would be the most innovative and efficient method for the

detection of oral carcinoma. Once the coated quantum dots with special substances are delivered, they will attach themselves to cancer specific cells and effuses ultra-violet spectrum. The light which is emitted has a different wavelength which is altered by the crystal size.¹⁷

CONCLUSION: The application of nanotechnology in dental science is a novel proposition. The advantages of the nanotechnology would enhance the effectiveness of the already available technology. However, one cannot ignore the negative implications of the nanotechnology and hence the pros and cons of the technology must be considered before employment for commercial purposes. With time, nanotechnology has the potential to play a vital role in the both dental and medical fields.

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Source of support: Nil

Conflict of interest: None declared

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