



## NANOTECHNOLOGY IN ORTHODONTICS – A REVOLUTION ?

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**ABSTRACT** Nanotechnology is manipulating matter at nanometer level. Nanotechnology is very diverse , ranging from extensions , of conventional device physics to completely new approaches based on molecular self assembly , from developing new materials, with dimensions on nanoscale This concept can be applied to the field of medicine and dentistry with the terms Nanomedicine and Nanodentistry being used respectively. This review provides an early glimpse on the impact and future implication of nanotechnology in orthodontics.

**KEYWORDS :** arch wires, brackets, nanorobots, orthodontics, revolution

### 1. Introduction

Nanotechnology ( nanotech) is the manipulation of matter on an atomic , molecular and supramolecular scale.<sup>1</sup> The word nano originates from the Greek word "dwarf".<sup>2</sup>

Nanotechnology is the science of manipulating matter measured in the billionths of meters or nanometer, roughly the size of 2 or 3 atoms.<sup>3</sup>

Nanotechnology is very diverse , ranging from extensions , of conventional device physics to completely new approaches based on molecular self assembly , from developing new materials, with dimensions on nanoscale , to investigating whether it can directly control matter on atomic scale.<sup>4</sup>

As documented in literature , On 29 th of December 1959 , at the American Physical Society meeting ( Caltech ) , Richard Feynman in his lecture on " There's plenty of room at the bottom " , first spoke about nanotechnology .He concluded by saying that " This is a development which I think cannot be avoided ".The term 'nanotechnology' was coined by Prof. Kerie E. Drexler, a lecturer, researcher, and writer of nanotechnology.<sup>5</sup>

According to Freitas [2000]<sup>6</sup>, nanodentistry will improve the provision of oral health care by involving the use of nanomaterials, biotechnology (including tissue engineering) and, ultimately, dental nanorobotics (nanomedicine).

The article aims to highlight the revolutionary era of advancing nanotechnology in the field of orthodontia.

### 2. Applications

#### I. Orthodontic Brackets<sup>7</sup>

Use of nanotechnology to resolve the friction issue between the tooth and the bracket was incorporated by Juan Baselga , head of the Universidad Carlos III de Madrid (UC3M) Polymers and Composite Group. The tentative solution to the problem proposed by him was use of evenly dispersed very hard nanoparticles in the poly sulfone ( polymer mould used in the industrial manufacturing orthodontic braces )

Advantages of the new material introduced by UC3M were

- Increase in mechanical and frictional Resistance
- Maintaineance of bracket transparency
- Better wear and tear resistance
- Biocompatible

#### II. Nanocomposite :

When inorganic phases in an organic/inorganic composite become nano-sized, they are called Nanocomposites. Nanocomposites are available as nanohybrid types containing milled glass fillers and discrete nanoparticles (40 – 50 nm) and as nanofill types, containing

nano-sized filler particles, called nanomers and agglomerations of these particles described as nanoclusters. The intense interest in using these nanomaterials stems from the idea that they can be used to manipulate the structure of materials to provide dramatic improvements in electrical, optical, chemical and mechanical properties .There are 2 types of nanocluster fillers. The first type consists of zirconia-silica particles synthesized from a colloidal solution of a zirconyl salt and silica.<sup>8,9,10</sup>

#### III. Nanomechanical sensors for orthodontic forces and moments measurements

Researchers have been working towards development of brackets that can carry three dimensional mechanical sensors , to measure the real time forces that have been applied to the teeth .

In order to achieve this Lapatki ( 2007) proposed the introduction of " smart" bracket . A large size prototype bracket that utilized microsystem chip encapsulation .Development of the nano chip that can be encapsulated into small low profile bracket systems with reduced mesio distal and occluso gingival dimensions will allow the clinical testing of utilization of this technology.<sup>14,15</sup>

#### IV. Nano coated Arch wires :

A recent innovation in the form of metal nanoparticle coating has been introduced that significantly reduces friction of various surfaces including archwires. The coating consists of electrodeposited Ni film impregnated with inorganic fullerene-like nanospheres of tungsten disulfide.<sup>13</sup>

**Syed SS Kulkarni (2015 )<sup>14</sup>** Used three types of orthodontic wires , stainless steel ,titanium molybdenum and nickel titanium and coated them with a uniform and smooth nanoparticle film using 100 ml of nanoceramics with the sol gel thin dip coating method.

The coating procedure was verified by comparing the surface topography of nanocoated archwires with commercially available arch wires in an environmental scanning electron microscope .The ESEM images were found to be smoother with less surface deteriorations than the conventional ones.

#### V. Orthodontic Nanorobots

Orthodontic nanorobots working on acoustic data signals could directly manipulate the periodontal tissues , allowing rapid and painless tooth straightening, rotating and vertical repositioning within minutes to hours .

Nanorobot design consists of a biocompatible glycocalyx-coated diamondoid material with molecular sorting rotors and a robot arm (telescoping manipulator). Different nanorobot molecule types are distinguished by a series of chemotactic sensors and their functioning is controlled by a stimulator.

Nanorobots 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 tumors.<sup>15</sup>

### 3.Future applications of nanotechnology in Orthodontics

- I. Nanodesigned orthodontic bonding materials
- II. Nanovector for gene delivery to stimulate mandibular growth.
- III. Nano – LIPUS devices

### 4.Conclusion

Nanotechnology, is science, engineering and technology conducted at nanoscale, which is about 1 -100 nano meters. Though in its infancy now, the forthcoming question which still awaits an answer is if nanotechnology is really the next big revolutionary change the world is going to see in the next decade?

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