

Nanotechnology: The future of dentistry

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The human characteristics of curiosity, wonder and ingenuity are as old as mankind. For many years people around the world have been harnessing their curiosity into inquiry and the process of scientific methodology. Science is the fuel for the engine of technology! And hence the fuel for progress, this article intends to highlight the success of the science and technology of miniaturization, i.e. nanotechnology in dental care applications such as composites, bonding agents, and impression materials.

Key words: Composites, dental, nanotechnology

'For I dipt into the future, far as human eye could see, saw the vision of the world and all the wonder that would be' (Tennyson, Locksley Hall).

The recent thing that we will be talking about is nanotechnology! The speed at which advances are being made in science has catapulted nanotechnology from its theoretical foundations straight into the real world. Dentistry also is facing a major revolution in the wake of this technology having already been targeted with novel 'nano-materials.'

WHAT IS NANOTECHNOLOGY?

The term 'nanotechnology' was coined by Prof. Kerie E. Drexler, a lecturer, researcher, and writer of nanotechnology.^[1] Nanotechnology is distinguished primarily by the scale at which it acts; one-billionth of a meter or one-ten-thousandth the width of a human hair involving individual atoms or molecules. In simple terms, it is engineering at the atomic or molecular scale [Figure 1].^[2]

WHAT ARE THE POTENTIAL BENEFITS OF NANOTECHNOLOGY?

- (1) The ability to exploit the atomic or molecular properties of materials.
- (2) The development of newer materials with better properties.

HOW ARE THE NANOPRODUCTS MADE?

- There are two perspectives
- (1) Building up particles by combining atomic elements

- [Figure 2].
- (2) Using equipment to create mechanical nanoscale objects.

INDIVIDUAL ATOMS + MOLECULES = COMPLEX STRUCTURE (extraordinary properties)

WHICH EQUIPMENT IS USED?

For example, NanoMan System, CP-II Scanning Probe Microscope. The BioScope Atomic Force Microscope delivers resolution on the nanometer and angstrom scales comparable to electron microscope but without its cumbersome sample preparation (Veeco Instruments, 2004).^[3]

APPLICATIONS OF NANOTECHNOLOGY IN DENTISTRY

'The emerging fields of nanoscale science, engineering and technology the ability to work at the molecular level, atom by atom, to create large structure with fundamentally new properties and functions – are leading to unprecedented understanding and control over the basic building blocks and properties of natural and man-made things' (Dr. Edward Reifman, Nanotech dentist).^[1]

NANOPRODUCT: NANOCOMPOSITES

NanoProducts Corporation has successfully manufactured nonagglomerated discrete nanoparticles that are homogeneously distributed in resins or coatings

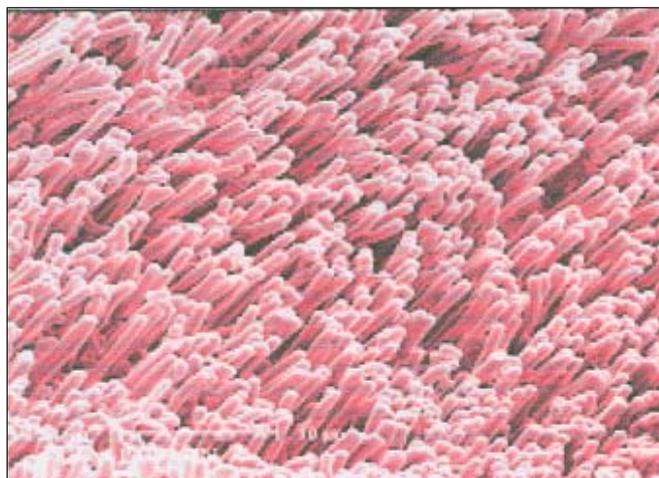


Figure 1: Microphotograph of particles under Scanning Electron Microscope (Image courtesy Dr. Mei Gao, CSIRO Molecular Science)



Figure 2: The nanoparticles

to produce NanoComposites [Figure 3]. The nanofiller used includes an aluminosilicate powder having a mean particle size of about 80 nm and a 1 : 4 M ratio of alumina to silica. This nanofiller has a refractive index of 1.508.^[3]

Advantages

- Superior hardness;
- superior flexural strength;
- superior modulus of elasticity;



Figure 3: Nanocomposites

- superior translucency and esthetic appeal, excellent color density, high polish and polish retention;^[4]
- about 50% reduction in filling shrinkage;
- excellent handling properties.

All these characteristics make the nanocomposites superior to the conventional composites and blend with natural tooth structure much better.

Trade name

Filtek™ Supreme Universal Restorative Pure Nano™.

NANOPRODUCT: NANOSOLUTION

Nanosolutions produce unique and dispersible nanoparticles, which can be added to various solvents, paints and polymers in which they are dispersed homogeneously.

Adper™ Single Bond 2 adhesive incorporates 10% by weight of 5 nm diameter spherical silica particles through a process that prevents agglomeration. As discrete particles, their extremely small size keeps them in colloidal suspension.^[3,5]

Advantages

- Higher dentine bond strength and better performance [Figure 4].
- No shaking of bottle required since the nanoparticles

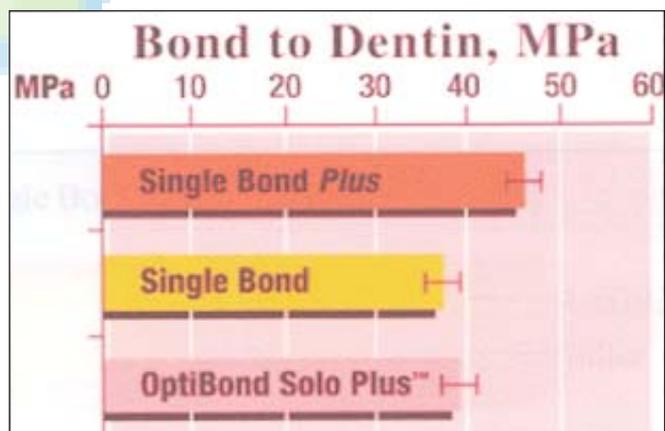


Figure 4: Microtensile bond evaluation shows significant improvement in dentin bond strength. Dr. Jorge Perdigao (University of Minnesota, MN, USA)

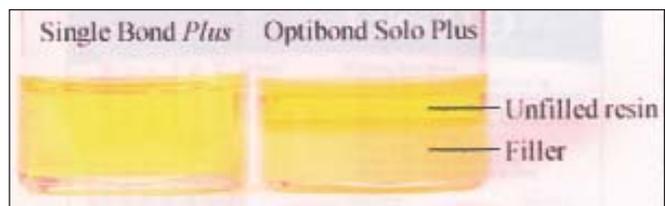


Figure 5: A comparison between Nanosolution and conventional bonding agent

are stable, neither do they cluster nor do they settle out of dispersion (in contrast, larger fillers tend to settle out of solution and such adhesives require routine shaking before use, Figure 5).

Thus, the use of nanotechnology in bonding agents ensures homogeneity and so the operator can now have total confidence that the adhesive is perfectly mixed every time.^[3,5]

Trade name

Adper™ Single Bond Plus Adhesive Single Bond 2.

NANOPRODUCTS: IMPRESSION MATERIALS

Impression materials are available with nanotechnology application. Nanofillers are integrated in the vinylpolysiloxanes, producing a unique addition siloxane impression material.

Advantages

- Better flow,
- improved hydrophilic properties hence fewer voids at margin and better model pouring,
- enhanced detail precision.

Trade name

NanoTech Elite H-D+.

Imprint II Penta H

These were glimpses through only a few of the nanoproducts. Another question that nanotechnology can answer is – IS TOOTH LOSS INEVITABLE?

The answer is – NO! In fact, when nanotechnology arrives within the next 10–20 years, it will put a halt to the genetics behind tooth loss, gum disease and bone loss in the jaw due to aging. Nanotechnology is being used in teeth and bone replacements by copying the way nature itself lays down minerals (this process is called bio-mimicry).^[3]

CONCLUSIONS

‘Men, my brothers, men, the workers, ever reaping something new; that they have done, but earnest of the things that they shall do’ (Tennyson, Locksley Hall).

Despite being one-billionth the size of a pinhead, the nanometer and the research being conducted around this tiniest of measurements, is sending huge waves of anticipation and speculation through the scientific and product manufacturing communities. The far reaching potential of nanotechnology is now making it one of the most important and exciting areas of science. As with all emerging technologies, a successful future for nanotechnology will only be achieved through open sharing of ideas and research findings, thorough testing and frank discussions.^[6]

To end with

‘How very small the very great are!’ (Thackeray, Vanitas Vanitatum). Similarly, the greatness of this technology lies in its minuteness, i.e. nano-ness!

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