

# **NANO-HYDROXYAPATITE GREAT DEVELOPMENT IN REGENERATION OF ENAMEL AND EFFECTIVE DECREASE IN TOOTH SENSITIVITY**

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## **Introduction**

For some time now, the tooth care sector has developed a series of products to return the natural whiteness of teeth, improve the microscopic structure of teeth, and keep them safe and healthy. The physical principle used for this purpose, which is based on the cleansing technology and abrasion of the plaques of teeth, has not changed in the tooth care sector up to now. Although the technique of abrasion is considered the most appropriate method, there is no doubt that brushing defects to some extent the surface of the teeth. Nowadays, there is a fundamental technology, which moves towards the tooth care products, and includes fast regeneration of enamel and protecting it against erosion.

## **A Big Market for Tooth Care Products**

Without any doubt, tooth care products have a big market. The cost allotted worldwide for the purchase of toothpaste is estimated to be about 1.3 – 1.6 billion dollars. There are a lot of developed methods for tooth and oral care, and therefore special products has been distributed in the markets for prevention from formation of plaque, prevention from decay, dual care products for teeth and gums, toothpaste for (cigarettes) smokers, toothpaste 2 in 1 (toothpaste and mouthwash), toothpastes for sensitive teeth, etc..

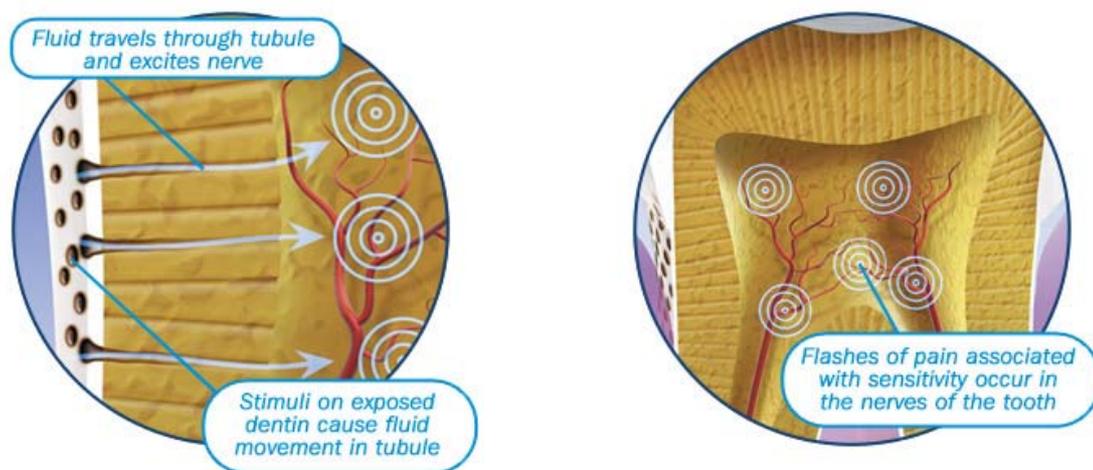
Therefore, the market of these products is saturated with all kinds of the products having different brands. Nevertheless, the significant property observed usually in all these products is the calculation of weight percent based upon economic considerations.

The low-priced toothpastes contains calcium carbonate as an abrasive, while the stronger abrasives such as calcium phosphates can provide the teeth with a source of calcium for the mineralization of teeth. The more high-quality products containing special silica particles are softer than the tooth, and harder than the plaque formed on teeth.

## Nanotechnology for Production of Hydroxyapatite

The tooth enamel is formed from hydroxyapatite (HAP) with the formula  $\text{Ca}_5(\text{OH})(\text{PO}_4)_3$ , and its fluorinated derivative named fluoroapatite, which are both the hardest materials existing in the nature. Hydroxyapatite has a porous crystalline structure, and this structure causes the pigments of food precipitate on teeth. These pigments can be removed from the surface of the teeth only by chemical bleaching or strong abrasives. At the present time, the bleaching process is only performed by the dentists, and some kinds of lacquer, labels, bleaching gels have been introduced, which can defects the surface of tooth enamel. Using optical brighteners, such as brighteners used in the fabric detergents, or the white dyes, which is used in painting, are the other alternatives.

In addition to the above-mentioned facts, the pores on the surface of tooth enamel create a proper environment for the bacteria, which decay the teeth, and these bacteria can not be removed easily by abrasives used in toothpaste. In the susceptible people, whose tooth pores are relatively bigger, their teeth are more sensitivity if they exposes to hot or cold foods. The sensitivity of teeth is a global problem. Studies have shown that among every two European people one person, and among every three North American people one person, and totally 40 percent of the people around the world are suffering from the sensitivity and acute pain of their teeth. Mostly, the tooth sensitivity is because of the atrophy of gums and the exposure of tooth base to the oral cavity. The narrow microscopic channels named tooth tubules begin from toothpaste and extend to the more internal parts of the teeth and transmit directly the irritations such as warmth, coldness, sweetness, sourness, and etc. to the teeth nerves.



Among the various notions about the mechanism of tooth, "hydrodynamic theory" or "Brännström theory" has been broadly accepted. The hydrothermal theory is based on the assumption that when the fluids existing in the tubules of the teeth are influenced by the change in temperature or osmotic pressure, these fluids start to be transmitted and irritate the receptors sensitive to the pressure, and cause the neural irritation to be transmitted and as a result pain to be perceived. The involution of gums makes the said receptors to be more irritable through the microtubules, which are yet more vulnerable to exposure.

Recently, a well-known German company and its associated research centre succeeded to synthesize a new substance named nano-hydroxyapatite by using nanotechnology and integrate it in the formulation of its products. This new substance can effectively enhance the mechanism of regeneration of tooth enamel, and tangibly reduce the sensitivity of tooth. A large number of commercial products developed for sensitive teeth and existing in the markets are consist of mineral salts such as potassium nitrates, etc, which depolarize the end of these nerves and prevents the neural irritation to be transmitted; therefore it can be considered a kind of sedative agent. Nonhydroxyapatite can act immediately as an alternate substance and not only alleviate the pain but also cure the sensitivity of teeth basically.

Since the chemical composition of this product is fully similar to the main structure of tooth enamel, it forms a protective new layer made of tooth enamel having the thickness

of 1 to 2 micrometer and covers the open pores of tubules and eliminates the sensitivity of teeth. This credit-worthy company claimed through inserting this substance in the formulation of its toothpaste that, following 3 times tooth brushing about 80% of the open pores of tooth tubules will be covered and closed and after 20 times tooth brushing there will be almost no more open channels in the surface of teeth. The efficiency of the tooth care products using this substance has been confirmed by the clinical studies of ASTER CEPAC institution of Paris.

Researches of another well-known company which is active in manufacturing of the raw materials of cosmetics and hygiene products were also successful in production of nanohydroxyapatite. In this technology, the famous "bottom-up" process is used, which begins from the atomic or molecular precursors. The particles are synthesized through a hydrothermal process, using calcium hydroxide, phosphoric acid, and water without using ancillary agents. The stability of suspension depends strongly on production conditions, and the suspension can be dispersed in a spraying dryer through ancillary agents.

### **Regeneration of Tooth Enamel using Nanoapatite**

If we submerge a piece of tooth in a concentrated suspension of nanohydroxyapatite, and then dry it, we can observe under an electronic microscope a transparent boundary between the part submerged in the hydroxyapatite and the intact part (which is considered here as an internal reference). In the reference part we can observe the damages caused by tooth brushing under normal circumstances, but in the submerged part, differences are significant, because the tooth surface is covered completely by hydroxyapatite, which has a high concentration of dispersion. This layer shows that how much nanoapatite tends to be adsorbed on the tooth enamel. Therefore, it is logical to expect that the more diluted the formulation is, the more adsorption rate is.

To study this issue in a more practical level, the nanohydroxyapatite was used in toothpaste with 5 percent concentration. The related toothpaste was diluted in proportion of 1 to 10, and was rubbed through a fabric on the tooth, and the tooth was

washed. The tooth was studied under electronic microscope, and it was observed clearly that a sticky film was covered the defective areas of enamel. (Figure 1)



Fig. 1 Proof of concept. HAP adsorption on teeth (Source: R. Nörenberg, BASF AG)

## Conclusion

The modern technology of tooth regeneration using nanoapatite has encouraging advantages. By applying this method, the defective parts of tooth enamel will be naturally regenerated and the degeneration of tooth enamel will be repaired; therefore, there will be no need to medium toothpaste with weaker cleaning function.

The whiteness of tooth is achieved by the competition between regeneration of tooth enamel and degeneration of a layer of enamel. Additionally the open pores of microtubules of tooth are covered by nanohydroxyapatite and the sensitivity of tooth is reduced significantly. The said results caused the oral care sector pay more attention to this phenomenon.

## References

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