EC DENTAL SCIENCE
Opinion

Importance of Corrosion Resistance in Dental Materials

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The field of dental materials is highly catholic in nature. As metal alloys have high strength and have been found to be competitive among others, so it is necessary to remember that the choice depends on many factors.

A gradual development of high performance dental materials to meet the various requirements has resulted, due to an increased knowledge about interaction of dental materials with oral environment.

For selecting an alloy or material to be used for implant procedure, it is necessary to remember that, there is a number of factors like corrosion behavior, mechanical properties, biocompatibility and cytotoxicity, and also the availability and cost, while the aesthetic measures needed are in a second priority. The most important property is corrosion behavior as it is responsible for the continuity of the mechanical properties beside the biocompatibility and cytotoxicity caused by the corrosion products.

Metal and alloys in the mouth are exposed constantly to changes in physical and chemical environment, which includes the rapidly fluctuating temperature and the widely changed pH from the components like saliva, salts, foods, liquids and drugs. So, corrosion of metals and alloys in the mouth is expected and does occur [1].

Corrosion is defined as the destruction or deterioration of a material due to its reaction with the surrounding environment [2]. Furthermore, it is important to know that there are other factors rather than surrounding environment will affect the corrosion behavior of the alloys, as the purity of the materials and the casting and melting techniques used during fabrication [3].

Corrosion was classified by Upadhyay into eight forms as follows: (1) Uniform or General corrosion, (2) Galvanic or Two-Metal corrosion, (3) Crevice corrosion, (4) Pitting corrosion, (5) Intergranular corrosion, (6) Selective leaching corrosion, (7) Erosion corrosion (including Fretting corrosion), and (8) Stress corrosion [4]. The most important form of corrosion for implantology is Fretting corrosion (form from Erosion Corrosion), as it is a degradation process resulting from the combined action of small movements between contacting parts and the corrosivity of the environment [5]. This will lead to tissues inflammation caused by degradation of metallic materials used in prosthetic implants which can lead to failure of orthopedic surgical operations [6].

Indeed, fretting corrosion results in metal degradation due to simultaneous action of mechanical wear and of (electro)chemical oxidation in a complex way depending on each other [5,6], however, the nature of the passive film and the electrochemical conditions play a relevant role in fretting corrosion [5].

The discovery of relatively inert metallic and alloy biomaterials, as Pure Ti or Ti alloys, and to a lesser extent Zr, has led to their use in the field of biomedical applications specially in dentistry. These metallic biomaterials are highly reactive and when exposed to fluid media or air, quickly develop a dioxide layer of TiO_2 or ZrO_2. This layer forms a boundary at the interface between the biological medium and the metal structure, which produces passivation of metal [7-10].

No metal or alloy is entirely inert in Vivo, so corrosion is one of the possible causes of implant failure after initial success, that is why management and control of corrosion is a crucial problem from biological, metallurgical and economic standpoints [1].

Titanium and its alloys have been used for long time as dental materials specially for implants, because they are covered with thin passive films (surface oxide) consisting of low-crystallite, or amorphous structures, which are correlated to corrosion resistance. However, researchers found that there are problems with these films such as corrosion and fracture (implants); which caused either by the presence of fluoride in tooth paste, mouth-rinses, and the prophylactic agents used as prevention of dental caries, or by the presence of peroxides in denture base cleaning agents [11-20].

It was found that corrosion resistance depends on the fluoride concentration, the increased pH, and the amount of dissolved oxygen in media [1].

After many years researchers improves that Ti and its alloys in market are not the best as implant material and this is the reason for implant failure. New Ti alloys come to the field and improve better results specially in corrosion resistance [1].

A little platinum or palladium was added to titanium alloys, so good corrosion resistance was obtained in a fluoride-containing solution, which was caused by anodic polarization of titanium due to surface enrichment of palladium or platinum [21].

Also, Anusavice (1996) said that adequate passivity film for alloys containing Chromium could be achieved if the alloy contains a minimum of 12% Cr [22].

Experimental alloy Ti-20 mass% Cr was reported to have the least tarnish among several Ti alloys examined by immersion in an acidic saline solution containing fluoride or hydrogen peroxide [23,24]. However, Ti-Cr20% has similar corrosion resistance of Ti in a saline solution, it has higher corrosion resistance in a saline solution containing fluoride up to +0.7 V and this was attributed to the formation of a Cr-rich oxide film [25].

In 2009, different Cr concentrations in Ti-Cr alloys were examined in terms of corrosion resistance in fluoride-containing saline solution, and surface texture. They found that, the amount of Cr oxide in the oxide films, which improves the corrosion resistance, was correlated with the amount of Cr content in the alloy. Ti-20%Cr alloy was the best for all experimental study, and they found that the increase in Cr oxide would decrease the potential for contact between Ti oxide and fluoride solution [26].

From my opinion, until now there is no ideal metal or alloy to be corrosion resistant, that is why more researches are needed for that.

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