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# METALLIC INSTRUMENTS CORROSION USED IN DENTAL OFFICE

Ștefan Lucian BURLEA, Maria Alexandra MARTU, Ioana MARTU
Gr. T. Popa" University of Medicine and Pharmacy, University str. no. 16,
700115, Iaşi, Romania

Dental instruments are the tools that dental professionals use to achieve dental treatment. These include tools for examination, handling, restoration and removal of adjacent teeth and oral structures. Dental instruments and dental rotary instruments are made of stainless steel or titanium and its alloys. In this paper we present various corrosion types of these materials and experimental results on corrosion.

## 1. Introduction

Dental instruments are tools that dental professionals use in dental therapy. They are made of materials resistant to corrosion, in most cases stainless steel, figure 1.

The examination tools allow specialists to work with biological tissues in order to better visualize the intervention area during treatment or an examination session.

Stainless steels are having more and more uses due to the extraordinary characteristics they possess. One of these traits is a strong resistance to corrosion regardless the environment in which they are used. The aim of this paper is to present succinctly the behavior of a stainless steel in a corrosive environment like the saline environment.


Fig. 1 Dental instrument made of stainless steel

The resistance to corrosion of stainless steels generally increases with the increase of the chrome content. Many explanations have been offered for the fact that the chrome confers steel resistance to corrosion. The general belief is that the presence of sufficient quantities of chrome leads to the formation, at the steel surface, of a thin, waterproof layer of oxide that hinders subsequent oxidation or corrosion. Environments of oxidant nature increase the resistance of this film, while reductive environments tend to destroy it, thus causing steel corrosion. [1, 2]

This theory of achieving passivity with the help of an oxide layer has been confirmed by many experiments [3-7]. These films have been isolated to determine their structure and chemical composition. The results of the experiments show that these films are made of substances similar to a gap, not having a well-defined crystalline structure.

A lot has been published about the resistance to corrosion of the specific traits of stainless steel in certain environments. Literature data follow both controlled laboratory trials, as well as real findings in practice. In order to discuss corrosion data, this topic is divided into four parts as follows: atmospheric corrosion, high temperature corrosion, intercrystalline corrosion and pitting corrosion [8,9].

Pitting usually occurs during continuous exposure to relatively weak corrosive environments, such as chlorides, to which steels are otherwise very resistant. Not much is known about this type of corrosion except that it occurs in certain vulnerable spots in which the passivity is continuously destroyed. Pitting is actually manifested by small cavities or spots unevenly spread on the steel surface in contact with other materials, leather, glass or grease. The cause may be the formation of an electrolytic cell. The mechanism probably implies a lack of oxygen on the surface of the metal which is being corroded [10-12].

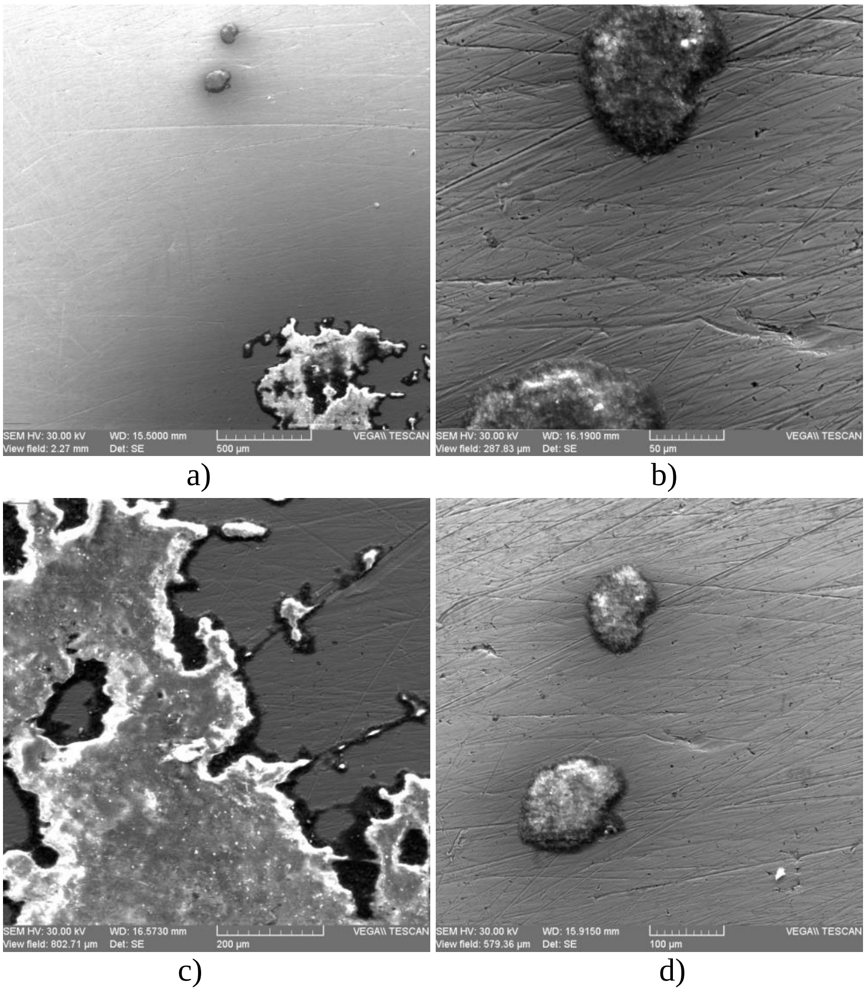
Pitting corrosion can be prevented by treating the environment with some strong oxidation agents such as chromates and phosphates. Adding molybdenum to steels 18-8 also prevents Pitting corrosion.

## 2. Experimental set-up.

The resistance of a stainless steel material kept in a saline solution for a period of 165 days was analyzed. The sample in direct contact with the saline solution had a shape of a cube with a face of 1 $cm^2$ and the material immersion into the corrosive solution was done statically without any other mechanical implications of or on the environment.

## 3. Experimental results

Figure 2 shows the state of the surface of the investigated material. One can notice a small number of corrosion affected areas, a generalized corrosion with the formation of foreign compounds on the surface that went into the solution following a chemical interaction with the metallic material.



a) b) c) d)

Fig. 2 The analysis of the surface of the investigated material after the corrosion resistance test in saline solution for 165 days for different amplifying strengths a) 100xm; b) 500xm; c) 1000x and d) 2000x

From the electronic microscopy on the surface, it can be observed that less than 5% of the surface is corroded locally, hence a very good behavior in this environment which is normally reactive.

Figure 3 shows the distribution of the elements Fe, Cr, Cl and O on a corroded area of the material surface. It can be noticed on the left side of the diagram that the elements characteristic to steel are totally reduced by the layer of oxides on the surface and the formation of chlorine based compounds on the rest of the surface.

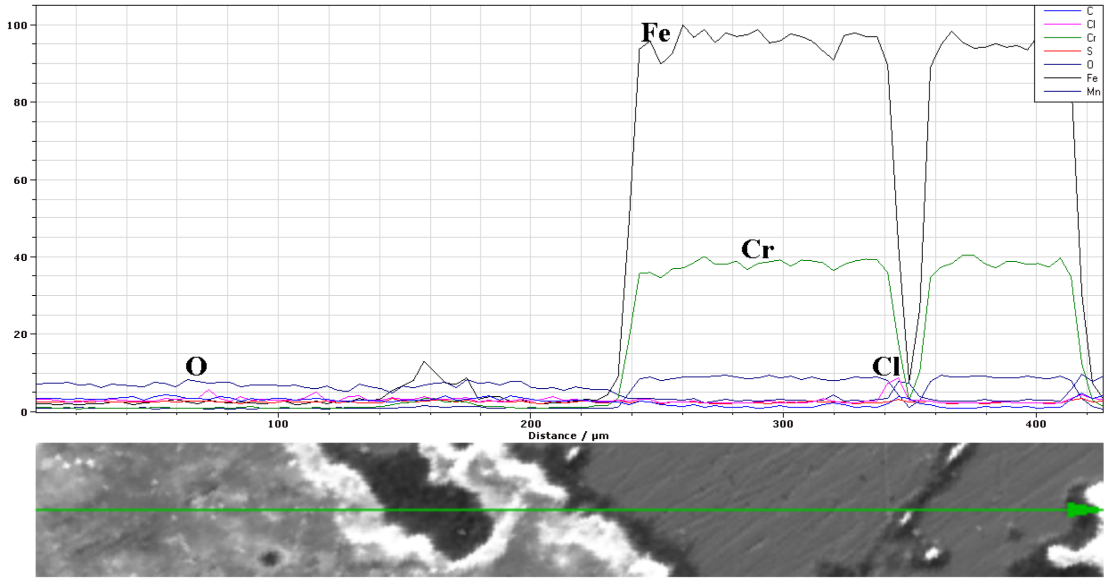



Fig. 3 The distribution of Fe, Cr, Cl and O on a corroded area on the surface of the material

Several spots relevant for the areas affected by corrosion were selected then for chemical analysis. The first spot was selected in the oxides area where their thickness was estimated to be the greatest. The second spot was situated on an area without reaction compounds, at least not macroscopically detected.

It is to be mentioned that no signs of pitting were found on the whole surface of the material.

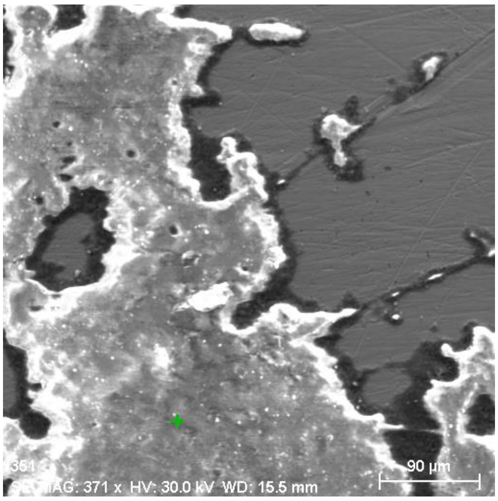



Fig. 4 The analysis of the surface of the investigated material after the corrosion resistance test in saline solution for 165 days at 500xm

Table 1 shows the experimental results following the chemical analyses. They are the result of investigations in a focus point on 100nm. The chemical analysis of the compound formed on the surface following immersion into sea water shows that this is basically oxide, with a high percentage of O, in terms of both weight and number of atoms, but it can also be noticed the presence of high calcium and carbon percentages completed by sodium and chlorine. These elements come from the solution in which the material was immersed, in time they migrating onto surface.

Table 1 The chemical composition in the spot selected in figure 4

| Element | wt.% | at.% | Error in % |
|---|---|---|---|
| Oxygen | 65.76 | 80.54 | 0.68 |
| Calcium | 29.82 | 14.58 | 0.94 |
| Carbon | 2.232 | 3.642 | 0.508 |
| Iron | 1.047 | 0.367 | 0.062 |
| Sodium | 0.78 | 0.66 | 0.096 |
| Chlorine | 0.34 | 0.19 | 0.041 |
| | 100 | 100 | |

In conclusion, at micron level, we can observe a great number of compounds of chlorine, sodium and oxygen that cover the surface of the material and form crusts on the stainless material.

The micro-structural analysis of the material surface gives a lot of significant information regarding the compounds that occur after the corrosion resistance test in an environment, with various medical applications.

The chemical analysis at macro and micro-structural levels completes the information acquired through morphological characterization and determines the nature of the compounds that appear.

## 4. Conclusions

Following the immersion of a stainless steel in sea water for a period of 165 days, one can notice a very good behavior of the surface of the metallic material without aggressive corrosion marks, but with the formation and growth of limestone deposits (CaO) on the material surface, based on the calcium and magnesium carbonates, as well as the occurrence on these deposits of some salts from the sea water.

The areas on which these formations occur are determined selectively by the shape and aspect of the material surface. There are also free, clear areas without chemical formations elsewhere; at higher amplifying strengths, a slight roughening of the surface through submicronic pitting is also noticed.

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