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Stability of Some Copper-based Dental Materials in Artificial Saliva

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Cu-Al-Ni based alloys, although are included in the category of inferior non-precious alloys, are still widely used in many countries, unofficially accepted in absence of some international standards, especially due to their low cost, the satisfactory tolerance and perhaps to their aspect, similar to that of the gold-based alloys. Contrary, in many countries the cooper-based alloys are not accepted as biomaterials, especially due to their high citotoxicity.

The corrosion behaviour of copper-based alloys (Gaudent and NPG+2) in simulated saliva was studied by potentiodynamic polarization and by electrochemical impedance spectroscopy (EIS). Were established the main parameters of the corrosion process. The keeping of these alloys in solution reduces the intensity of the corrosion process but not the influence the type of the corrosion. In all cases a pitting corrosion was evidenced. The obtained results were completed with microstructure observation and SEM analysis. It was found that both alloys present (the) similar corrosion rates, so the alloying of the copper-based alloy with gold 2% (NPG+2) does not have a significant effect on the corrosion process.

Present paper made a comparative study of two cooper-based dental alloys: NPG+2 (non-precious gold) (Alba Dent, USA) and Gaudent (IMNR, Romania) with the composition presented in the Table 1, regarding the corrosion behaviour and also attempt to elucidate the copper dissolution mechanism in artificial saliva. The corrosion medium was an artificial aerated saliva (Carter-Brugirard AFNOR/NF (French Association of Normalization) having the composition: NaCl – 0.7 g/L, KCl – 1.2 g/L, $Na_2HPO_4H_2O$ – 0.26 g/L, $NaHCO_3$ – 1.5 g/L, KSCN – 0.33 g/L, carbamide – 1.35 g/L , and pH = 8.

The two alloys have a similar biphasic composition: α- phase and eutectoid γ'. As one can be seen in Figure 1, the difference between the two alloys is that the eutectoid γ' is *lamelar* in Gaudent and *globular* in NPG+2.

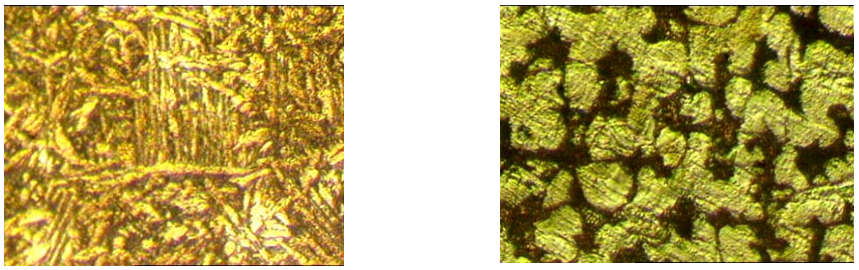
The corrosion type and the influence of the time period of immersion in solution for the studied alloys were analyzed on the basis of cyclic polarization curves. These curves were recorded both for samples with freshly polished surface and for samples maintained seven days in artificial saliva. In Figures 2 a) and b) are presented the cyclical polarization curves for Gaudent and NPG+2 alloys. The structure of the salt deposits on the Gaudent surface after electrochemical treatment is better evidenced by scanning electron microscopy in Figure 3.

Gaudent and NPG+2 alloys are very susceptible to pitting corrosion in artificial saliva, the process taking place at relative small over-potentials and with high corrosion current densities. Using two electrochemical methods (polarization resistance and EIS) it was found that both alloys present the similar corrosion rates , so the alloying of the copper-based alloy with gold 2% does not have a significant effect on the corrosion process. The type of corrosion do not modifies by maintaining

seven days of the both samples in artificial saliva but the corrosion current decreases by formation of an oxide layer and, probable, due to deposition of an insoluble salt layer. This last layer is rather weak adherent and can be easy removed on paper filter. The EIS measurements confirm the pitting type corrosion and suggest that the corroded surfaces have a complex structure. The Allen and Hickling equation indicates that the rate determining step of the corrosion reaction is only a one electron process.

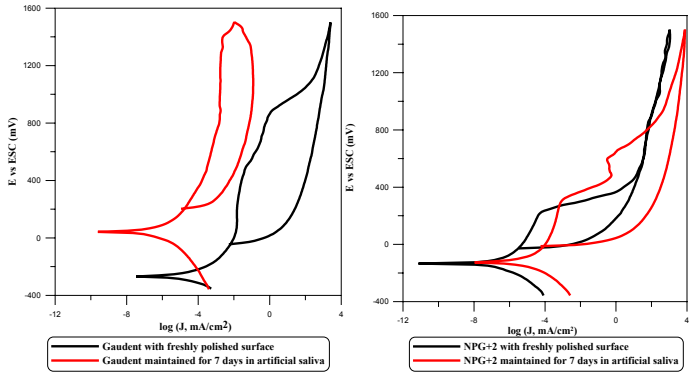
Table 1.Composition of the used alloys

Alloy	Composition (%)
Gaudent	82.42Cu ; 9.95Al ; 4.15Ni ; 2.13Fe ; 1.35Mn
NPG+2	77.3Cu ; 7.8Al ; 4.3Ni ; 3Fe; 2.7Zn ; 1.7Mn/ 2Au



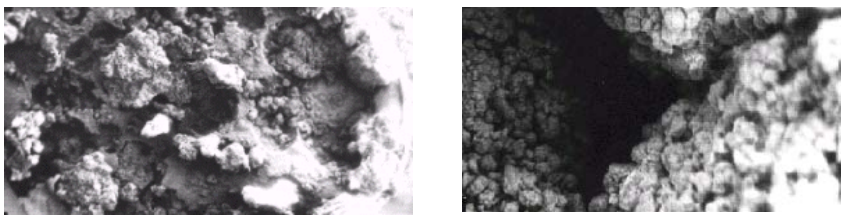
(a) b)

Figure 1. Microstructures of copper- based alloys (X1200): (a) Gaudent; (b) NPG+2



(a) (b)

Figure 2. Cyclic polarization curves in artificial saliva for: a) Gaudent; b) NPG+2



a) x60 b) x3000

Figure 3. SEM micrographs for Gaudent after polarization at +1,5 V in artificial saliva

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