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Cobalt-Chromium Dental Alloys Enriched with Precious Metals

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Introduction

Cobalt-chromium alloys are known to have excellent corrosion resistance. Because of their outstanding mechanical properties (e.g. high stiffness) these alloys are mainly used for the fabrication of removable partial dentures, but also for metal ceramic prostheses, where fine frameworks constructions are needed. A new generation of cobalt-chromium alloys enriched with precious metals (Au, Pt, Ru) are now coming on the market with the idea to improve the corrosion resistance. The goal of this study was to verify this hypothesis.

Material and Methods

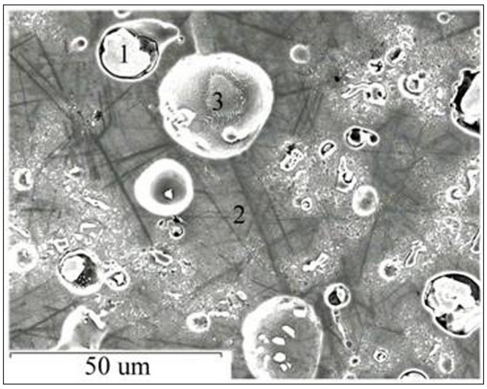
The chemical compositions (wt %) of the commercial tested alloys and of a "classical" Co-Cr alloy are given below:

Co-Cr:	Co 63.7, Cr 28.9, Mo 5.3, Mn 0.8, W 0.1, Fe 0.4
Alloy #1:	Co 63.5, Cr 21.0, Ga 4.5, In trace, Au 2.0, Pt trace, Mn 6.5, Al 2.5
Alloy #2:	Co 52.0, Cr 25.0, Mo 4.5, Ga 6.0, In 5.0, Au 2.0, Pt 2.0, Sn 1.0, Mn 0.5, Si 2.0
Alloy #3:	Co 50.6, Cr 18.5, Mo 3.0, Pt 15.0, Ru 10.0, Mn 1.0, Si 0.75, W 0.5, Nb 0.5, Ti trace
Alloy #4:	Co 59.3, Cr 25.0, Mo 5.0, Ga 2.5, In 1.2, Au 2.0, W 4.0

Before electrochemical testing the alloys were analyzed micrographically, analysis of phases by energy-dispersive X-ray spectroscopy (EDX) was carried out and hardness properties were also tested.

Results

Metalographical structures are shown in fig. 1-4.The microstructures of alloys #1 and #4 exhibited round "inclusions" with a diameter up to 0.1 mm. The chemical analysis of these zones showed of In (betweeen 42 and 51%), Pt (around 28%) and Au (between 18 and 27%).
The Vickers-hardness values are as follows: alloy #1overall: 333, alloy #2 overall: 435, alloy #3 overall: 338, alloy #4 overall: 326, alloy #4 zone 2: 147. The Vickers tests of such zones for #4 gave a mean hardness value more than twice lower (147 HV) compared to the overall hardness value of the alloy (326 HV).
Electrochemical measurements were conducted in artificial saliva of the Fusayama type (deaired with nitrogen, temperature 37°C, pH = 5) using the rotating electrode technique. The cathodic and anodic potentiodynamic polarisation curves were measured from 1000 mV to + 1250 mV vs. saturated calomel electrod (SCE).The potentiodynamic curves displayed in Fig. 5 reveal important differences in the behaviour of the studied alloys (#1 - #4) as compared to the conventional Co-Cr alloy. The worst behaviour was given by the alloys containing only gold (#1 and #4), confirming the results of Kappert and Schuster1. Au is not miscible to Co and Cr.



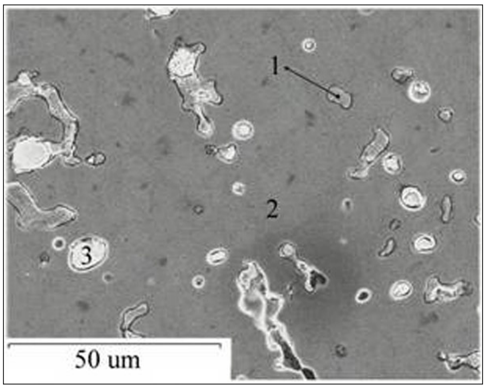
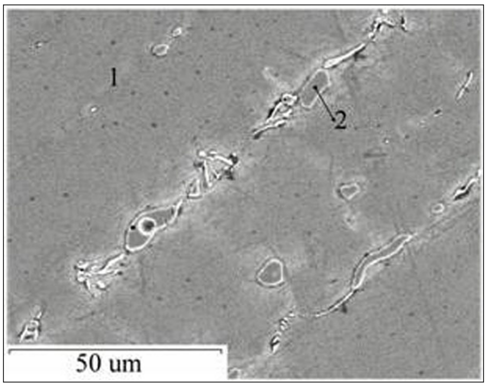


Fig. 1: Microstructure of alloy #1 and phases composition (wt %).

Fig. 2: Microstructure of alloy #2 and phases composition (wt %).



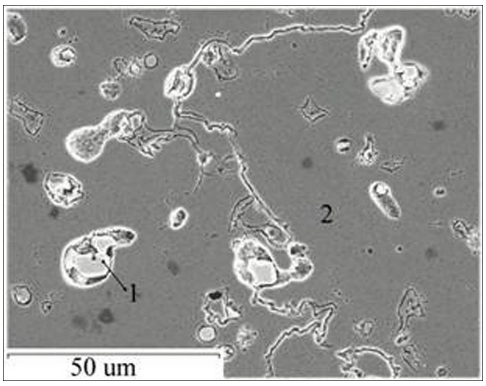


Fig. 3: Microstructure of alloy #3 and phases composition (wt %).

Fig. 4: Microstructure of alloy #4 and phases composition (wt %).

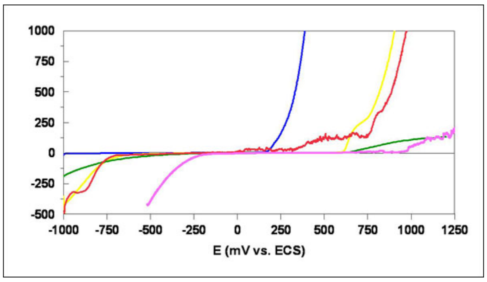


Fig. 5: Potentiodynamic polarization curves in linear system of alloys #1 to # 4 in comparison with a conventional Co-Cr alloy.

Conclusions

Alloys #1 and #4 showed a very complexe microstructure compared to the other studied alloys. The round "inclusions" with a diameter up to 0.1 mm are in part non miscible phases with a very low corrosion resistance. From the point of view of corrosion behaviour, the classical Co-Cr alloy is the best material followed by the alloys #2 and #3 (addition of respectively 4 % and 25 % precious metals). The worst alloys were #1 and #4 (with only addition of 2 % of Au). Scientifically speaking Co-Cr dental alloys enriched with precious metals is a non-sense.

Literature

1. H. F. Kappert, M. Schuster; Dental Labor 43 (3) (2000), 352-354.

This Poster was submitted by Prof. Dr. Lavinia Ardelean.

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