European Cells and Materials Vol. 5. Suppl. 1, 2003 (pages 53-54) ISSN 1473-2262

EXPERIMENTAL RESEARCHES CONCERNING THE Co-Cr-Mo ALLOYS USED IN IMPLANTOLOGY

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INTRODUCTION: Co-Cr-Mo alloys are used on a large scale in implants and prosthetics.The researches that are presented in this article, highlight the study of corrosion behavior and testing in environments of cellular cultures of an F75 ASTM alloy, used on a large scale in the entire world at the performing of implants and prosthesis. The aim of the researches consisted in obtaining the necessary results for establishing the implantation duration of the products performed from this biomaterial, elaborated in "Politehnica" University of Bucharest laboratories.

The researches were performed on Co-Cr-Mo alloy type, with the chemical composition specified according to ASTM F75. The main characteristic of this alloy is represented by its corrosion resistance in chloride environments, which is owed to both chemical composition and oxide formed on its surface (Cr_2O_3).

METHODS: To achieve the proposed objective there have been carried out tests concerning the cellular viability tests, corrosion tests, in two environments that stimulate the existent conditions in the human organism and also scanning electron microscopy investigation and EDS spectrometry over the samples subjected to the above mentioned tests. The alloy elaboration has been performed in a kiln in vacuum of Baltzers type heated at $1350/1450^0$ C and cast in bar shaped ceramic mould of 20mm diameter of cocsofemural tail prosthesis. The metallographic samples taken from the casting profile have been submitted to some initial investigations by a XL 30 ESEM scanning electron microscope, made by Phillips.

To confirm one of these aspects that express the biocompatibility of the analyzed alloy, the sample has been subjected to cellular viability tests, by increasing some fibroblast cellular cultures in the presence of the sample.

After performing these cellular viability tests, the sample has been prepared for corrosion tests in vitro, by cleaning in acetone and deionizer water with ultrasounds for 60 minutes.

The corrosion samples behavior was studied in two environments: artificial saliva and artificial physiologic solutions. The samples were immersed for 8 hours in the above mentioned solutions, and the tests were performed in special recipient protected against ventilation. It was determined the value of electrode potential of each sample in each solution and the modification of this potential has been recorded automatically from 5 to 5 minutes.

In order to establish the morphological modifications that appeared on the sample surface after performing the corrosion tests, the samples were analyzed by scanning electron microscopy, being obtained some images of the surface morphology [1,2]. (Secondary electrons images SE), images showing the compositional differences that appeared on the surface of the analyzed sample (backscattered electrons images BSE), and also morphological micrographs, by mixing secondary electrons signal with the backscattered electrons signal (Mix images).

Over the surfaces there have been performed EDAX quantitative compositional analyses and also analyses concerning the elemental distribution on corroded zones (mapping).

RESULTS: The determination of the chemical composition of the obtained alloy was made on samples obtained from the processed bar. The compositional analyzes was obtained with a spectrometer after an energy of EDAX type.

Table 1 EDAX compositional analyzes of Co-Cr-Mo alloy.

Element	Wt %	At %
AlK	0.22	0.47
SiK	1.01	2.06
MoL	5.57	3.32
CrK	27.70	30.49
MnK	0.35	0.36
FeK	0.60	0.62
CoK	63.54	61.70
NiK	1.01	0.98
Total	100.000	100.000

The results of the quantitative chemical composition analyses showed in table 1, confirms the alloy situation in F75 class, according to ASTM.

The study of the behavior in cellular culture environment of the selected alloy was established in comparison with the test performed on a pure titanium sample, by apoptosis analyzing.

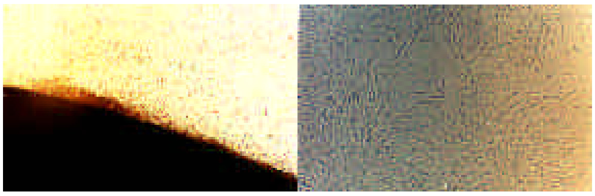

Fig. 1: Optical microscopy image in phase contrast for the Co-Cr-Mo sample at 20x magnification (left), and optical microscopy image in phase contrast for the etalon titanium sample, at 20x magnification (right).

With the displayed data obtained after the corrosion test, it was elaborated the electrode potential variation curve. (Figure 2)

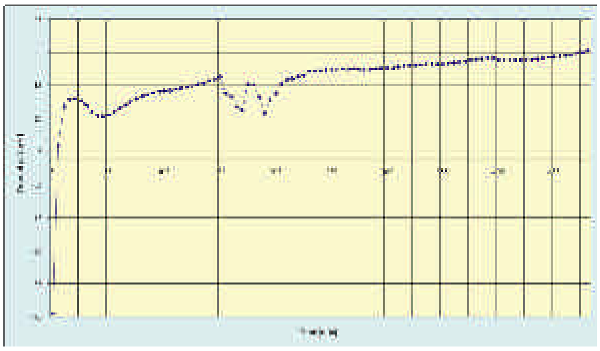

Fig. 2: Electrode potential variation curve for the test performed in artificial saliva environment.

In figures 3 and 4 are presented two micrographs where the surface morphology is tested in artificial saliva environment, thoroughly the surface morphology immersed in artificial physiologic solution.

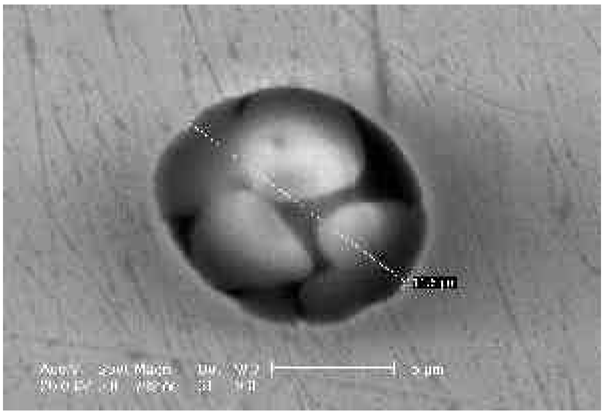

Fig. 3: The morphology of tested surface in artificial saliva environment.

DISCUSSIONS & CONCLUSIONS: F75 ASTM, Co-Cr-Mo alloy, presents important characteristics from the biocompatibility point of view, what recommends it for the usage at the obtaining of implants and prosthesis. The results of corrosion tests processed by our reserches highlights the fact that the alloy is pitting corroded due to submicron defects that appeared beyond casting and solidification [2,3].

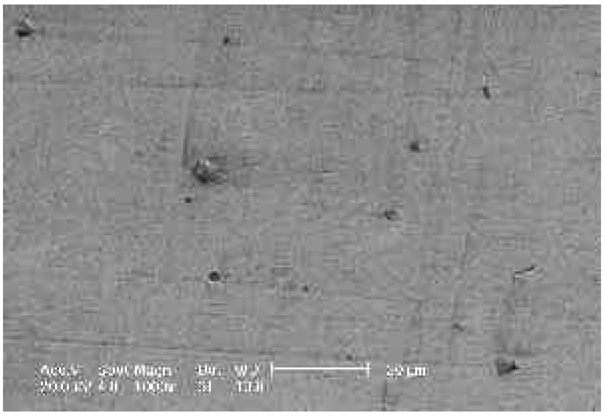

Fig. 4: The morphology of the surface immersed in artificial physiological solution.

Due to very good characteristics of corrosion resistance, the biomaterial is auto-passivated, resisting very well to the attack of corrosive factors from the human organism, so this alloy is recommendable for processing implants and prosthesis with a long term usage.

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