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INFLUENCE OF POTENTIAL ON THE ELECTROCHEMICAL BEHAVIOUR OF Co-Cr-Mo ALLOY IN SIMULATED BODY FLUIDS USING ELECTROCHEMICAL IMPEDANCE SPECTROSCOPY

J.L. Vázquez-Gutiérrez, A. Igual-Muñoz

Departamento de Ingeniería Química y Nuclear. Universidad Politécnica de Valencia. P. O. Box 22012, E-46071 Valencia. Spain. Tel. 34-96 387 96 32, Fax. 34-96-387 76 39, e-mail. anigmu@iqn.upv.es

INTRODUCTION: Co-Cr-Mo alloy is commonly used as implant biomaterial because of its high corrosion resistance, wear resistance, and fatigue strength. The corrosion resistance is imparted by a passive oxide film that forms spontaneously on the alloy surface. In this sense, the potential at which the passive film is formed may play an important role in the electrochemical behavior of the biomaterial.

The purpose of this work was to characterize the corrosion behaviour of a high carbon Co-Cr-Mo alloy depending on the applied potential for a range of 0, 100, 250 and 500 mV within the passive zone during 1 hour using Electrochemical Impedance Spectroscopy (EIS).

METHODS: Open-circuit potential (OCP), potentiostatic tests and AC impedance were measured in a three-electrode vertical cell. An Ag/AgCl, 3-M KCl electrode and a platinum electrode were used as reference and counter electrode, respectively. The experiments were carried out using four different solutions: NaCl, NaCl + albumin, Phosphate Buffered Solution (PBS) and PBS + albumin in order to analyze the influence of phosphates and albumin on the electrochemical behaviour of the biomaterial.

RESULTS: OCP values depend on solution chemistry. Main influence on the OCP was observed in presence of albumin molecules which decreases the OCP values. Applied potential slightly increases the passive current density at 0, 100 and 250 mV after 1 hour of immersion in the simulated body fluids. The influence of the applied potential is more significant at 500 mV and in the phosphate-containing solutions, while albumin slightly decreases the current density values in the whole potential range.

The EIS results agree with the dc results and they show that polarization resistance decreases at 500 mV and this decrease is higher in the presence of phosphates. Albumin mainly affects the capacitive behaviour of the interface.

DISCUSSION & CONCLUSIONS: The results show that there are not significant differences on the passivation kinetics depending on the applied potential, neither on the solution. However, differences were observed in the passive current density values. The increase in the current density at 500 mV was attributed to the breakdown of the passive film due to the displacement to the transpassive zone. This increase at 500 mV is higher in the presence of phosphates, due to the formation of phosphates-chromium ion complexes that activates transpassive dissolution.

These results agree with those obtained using Electrochemical Impedance Spectroscopy (EIS).

Therefore, the influence of applied potential on the electrochemical properties of the interface depends on solution chemistry. There is an interaction between species in the solution and the biomaterial surface depending on the potential and the nature of those species. In this sense, phosphates slightly decrease the resistance of the interface in the whole passive range, mainly at higher potentials, while albumin increases the resistance. Albumin effect disappears when phosphates are present in the solutions due to the competitive adsorption of both species.

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