THERMODINAMICAL ANALYSIS OF THE ADSORPTION PROCESS OF ALBUMIN ON CoCrMo BIOMEDICAL ALLOY. INFLUENCE OF SURFACE CONDITIONS

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CoCrMo alloys are biocompatible materials widely used for orthopaedic implants such as hip and knee joint replacements. The biocompatibility of CoCrMo alloy is closely related to its excellent corrosion resistance, imparted by a passive oxide film that forms spontaneously on the alloy surface **[1]**. The adsorption of organic species present in the synovial fluids may attach with this passive film and modifies their surface reactions. Thus, protein adsorption onto metallic surfaces affects the biocompatibility of the biomaterials since, an accelerated metal dissolution maybe favoured **[2]**. The first objective of this work is to determine the role of the albumin in the electrochemical behaviour of CoCrMo biomedical alloys. The second aim is to determine the effect of surface condition (oxidation time) on the adsorption mechanisms of albumin on the biomaterial.

The electrochemical techniques employed to carry out the study of albumin adsorption on CoCrMo surface are Open Circuit Potential (OCP), potentiodynamic curves, Electrochemical Impedance Spectroscopy (EIS) and Cyclic Voltammetry (CV).

The effect of protein interaction on the electron transfer processes at the electrode/solution interface was studied using EIS. The charge transfer resistance was very sensitive to the amount of adsorbed protein (surface concentration), indicating that the adsorption process was accompanied by charge transfer (via chemisorption) and influenced the mechanism and kinetics of the corrosion reaction. The adsorption of proteins onto CoCrMo surface has been described by the Langmuir isotherm (1) as can be observed in **Fig 1**.

$$\Gamma = \frac{B_{ADS}\Gamma_{\max}c}{1 + B_{ADS}c} \quad (1)$$

Where c (mol·cm^{-3}) is the equilibrium concentration of the adsorbate in the bulk solution, Γ (mol·cm^{-2}) is the amount of protein adsorbed, i.e. surface concentration, Γmax (mol cm^{-2}) is the maximum value of Γ, and the parameter B_{ADS} (cm^{3}·mol^{-1}) reflects the affinity of the adsorbate molecules toward adsorption sites.

Thermodynamic parameters of adsorption were obtained from both electrochemical techniques (EIS and CV) and results were consistent. Gibbs free energy of adsorption for BSA shows that the molecules have a strong affinity for the CoCrMo surface (-51 KJ·mol^{-1}). Enthalpy and entropy of adsorption suggested that the adsorption process of BSA onto CoCrMo surface is an endothermic process and the molecule suffers structural changes when adsorbing on the metallic surface **[3]**.

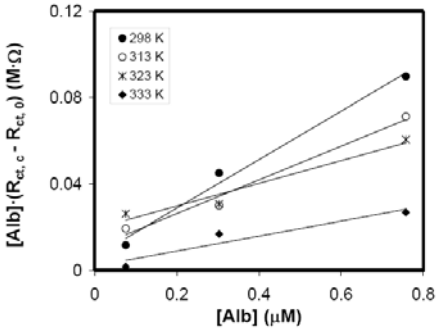

Fig 1. Langmuir adsorption isotherm presented in a linearized form, for BSA adsorbed onto the CoCrMo electrode in 0.14M NaCl solution (pH 7.4) at different temperatures.

The influence of the passivation time of the CoCrMo in phosphate buffered solution (PBS) on albumin adsorption was studied in order to investigate the mechanism of protein adsorption at different surface conditions. Adsorption kinetic was influenced by surface passivation when passivation time was lower than 1 hour. At higher passivation times, no apparent modification in the kinetic mechanisms of adsorption was observed. These results can be observed in the **Fig. 2**.

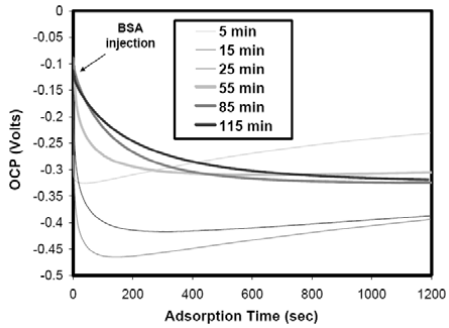

Fig 2. OCP evolution after BSA injection at different passivation times.

References

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