

ELECTROCHEMICAL CHARACTERIZATION OF BIOMEDICAL ALLOYS FOR SURGICAL IMPLANTS IN SIMULATED BODY FLUIDS

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INTRODUCTION: Stainless Steel AISI 316L and Co-based alloys are highly biocompatible biomaterials widely used as orthopaedic implant materials in clinical practice. Biocorrosion has been considered a problem for the long durability of implants into human bodies and the release of metal ions can cause adverse physiological effects, toxicity, carcinogenicity and metal allergy. The purpose of this work is to compare the electrochemical properties of both biomaterials.

METHODS: The electrolytes employed were 0.14M NaCl solution and Phosphate Buffered Solutions (PBS). In order to analyze the protein effect 0.5 g/l of albumin were added to both electrolytes. The temperature of the solutions was kept out 37°C and the solutions were adjusted to pH 7.4 (human body conditions).

The study of the electrochemical behaviour of biomedical materials in simulated body fluids was carried out using open circuit-potential, potentiodynamic polarization curves, potentiostatic measurements at different immersion times and electrochemical impedance spectroscopy (EIS).



Fig. 1: Plate and screws of AISI 316L

RESULTS: The study reveals that OCP values stabilize with time in the two biomaterials due to spontaneous formation of a passive oxide film.

Phosphates act as anodic inhibitor on AISI 316L and CoCrMo, while albumin acts cathodic or anodic inhibitor depending on solution chemistry and biomaterial.

Furthermore, EIS results for both biomaterials show the resistance of the interface under passive conditions increases in presence of albumin. Moreover, phosphate ions enhance the interface resistance value.

Immersion time decreases the charge transfer resistance of AISI 316L in all solutions, while on CoCrMo alloy charge transfer resistance increases in PBS solutions.

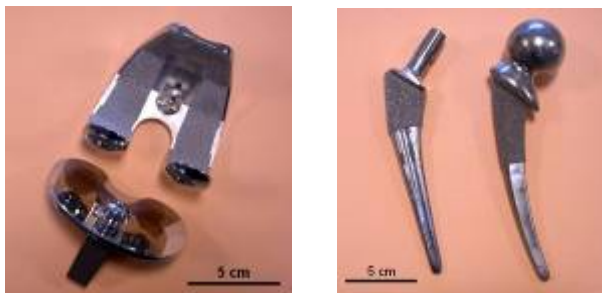


Fig. 2: CoCrMo knee implant (left)
CoCrMo hip implant (right)

DISCUSSION & CONCLUSIONS: Influence of Albumin on both biomaterials, depends on the nature of the alloy. It decreases the corrosion resistance of AISI 316L while increases the corrosion resistance of CoCrMo. Although it is known that it adsorbs in both cases, properties of the passive layer modifies the effect of albumin. On the contrary, precipitation of phosphate ions could explain the highest resistance values in the phosphate solutions on both cases.

The study shows that the electrochemical behaviour of CoCrMo shows higher charge transfer resistance and lower capacitance which means thicker passive films than AISI 316L.

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