Galvanic deposition of Chitosan-AgNPs as antibacterial coating

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Thanks to mechanical properties similar human bones, metallic materials represent the best choice for fabrication of orthopedic implants. Although metals could be widely used in the field of biomedical implants, corrosion phenomena could occur, causing metal ions releasing around periprosthetic tissues leading, in the worst cases, to the development of infections. In these cases, patients need prolonged antibiotic therapies that may cause bacterial resistance. Preventing bacterial colonization of biomedical surfaces is the key to limiting the spread of infections. Antibacterial coatings have become a very active field of research, strongly stimulated by the increasing urgency of identifying alternatives to the traditional administration of antibiotics.

Nowadays, the research was focused on coating science to deal with these issues. In particular, the development of the antibacterial composite coatings could be a viable way to provide not only a corrosion resistance but also an antibacterial action and biocompatibility. Chitosan is a great biomaterial used in medicine. It is a natural bioactive polymer and is the second most abundant in nature polysaccharide after cellulose. Chitosan comes from the deacetylation of chitin, a homopolymer of beta-(1-4)-N-acetyl-D-glucosamine, derived from exoskeleton of crustaceans [1]. It is high biocompatible and it is also used in drug delivery. In addition, chitosan has chelating properties due to the amino groups of polysaccharide that are responsible of selective chelation with metal ions. In particular, the attention has been paid to silver nanoparticles for their high stability, low toxicity, biocompatibility and antibacterial properties. These ones are incorporated in polymeric matrix (e.g. chitosan) and they are capable to interact physically with cell walls of bacteria.

In this study Chitosan-Silver nanoparticles composite coating on AISI 304L was investigated. These coatings were realized by an alternative method of deposition respect to traditional ones based on galvanic coupling. This process doesn't request any external power supply and is very easy to carried out. The difference of the electrochemical redox potential between the substrate (cathode) and a sacrificial anode is the pivotal role of the process [2-3]. Deposition rate is controlled by the ratio of cathodic and anodic area. In practice, electrons generated by anode corrosion flow towards to more noble metal thanks to a short-circuit. As soon electrons arrive to the cathode, the base electrogeneration reactions of nitrate ions and water molecules occur. Production of hydroxyl ions causes an increasing of pH at substrate/solution interface. Hence, deprotonation of amine group leads precipitation of chitosan (pKa=6.4) onto surface. At the same time, silver nanoparticles are incorporated in polymeric matrix of chitosan.

Physical-chemical characterizations of the coatings were carried out in order to investigate morphology and chemical composition. In addition, corrosion tests (potentiodynamic polarization and electrochemical impedance spectroscopy) were executed in a simulated body fluid to scrutinize the corrosion resistance. Furthermore, the release of silver nanoparticles from coating in SBF were studied.

References

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