Corrosion behavior of electropolished AISI 316L austenitic biomaterial in physiological solution

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Currently, austenitic stainless steels are one of three metallic biomaterials used in the manufacture of implants. Coronary stents, fracture fixation plates and screws, spinal implant devices, aneurysm clips, temporary fixation devices, dentistry and surgical instruments are the most common medical applications of austenitic biomaterials. Compared to titanium alloys and chromium-cobalt alloys, the advantages of stainless steels are suitable mechanical properties (strength, mechanical workability), low cost and acceptable corrosion resistance. Due to the protective passive surface film, stainless steels are resistant to the uniform corrosion, but possibility of local pitting or crevice corrosion have to be taken into account in an internal human body environment. The quality of surface, which depends on used mechanical and chemical surface treatment, plays the major role in the biocompatibility and corrosion resistance of austenitic implants.

Polished smooth surfaces are strictly required especially for surgical and dentistry instruments, ophthalmic devices, coronary stents, fracture fixation plates and screws. According to studies of many authors, bright smooth surfaces have markedly higher corrosion resistance and also provide increased resistance to micro-organisms that have less chance of getting caught than those with higher roughness. For the above mentioned biomedical applications, mechanical and electrochemical polishing of austenitic steels is commonly combined with pickling (acid cleaning), ultrasonic cleaning and chemical passivation. There are various polishing processes commonly used to obtain a smooth material surface. Traditional mechanical polishing may result in deformed layer and residual stresses on the treated surface. Electropolishing is an electrochemical surface finishing process to enhance high surface brightness (mirror finish) with very low surface roughness (R_a ¡ 2 μm), without residual surface tensions and with improved corrosion resistance.

The paper deals with corrosion resistance of AISI 316L stainless steel, which is the most widely used Cr-Ni-Mo austenitic biomaterial. Corrosion behavior of five various surfaces (original without additional mechanical and chemical treatment, electropolished, ground + electropolished, pickled + electropolished, ground + pickled + electropolished) are evaluated on the bases of cyclic potentiodynamic polarization tests performed in physiological solution at the temperature of 37 ± 0.5 °C. Obtained potentiodynamic curves are characterized, compared and analyzed for determination of electrochemical characteristics. After tests, the surfaces are checked by optical microscope observation.

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