

## IMPROVING THE ANODIZING PROCESS FOR MEDICAL IMPLANTS MADE OF TITANIUM ALLOYS

Masliak T.M., Madyka I.D., Leshchenko S.A.

*National Technical University*

*«Kharkiv Polytechnic Institute», Kharkiv*

A technological process for anodic oxidation of Ti6Al4V titanium alloy for medical implant production was developed in a previous stage of the study [1]. The aim of the subsequent research was to find ways to improve the process flow diagram and biocompatibility of the surface, as well as to reduce energy and material costs, and the process cost. Given the increased demand for the medical implant manufacture and the need to increase process productivity, the objective of the study was to adapt the technological process of titanium alloy anodizing for the implementation on automated production lines.

To do this, it was advisable to eliminate the manual cleaning operation with Viennese lime at the chemical degreasing stage. Several solutions were tested, and the best result was found in the case of solution containing sodium tartrate (3...4 g L<sup>-1</sup>), sodium formate (2–3 g L<sup>-1</sup>), sodium oxalate (3–5 g L<sup>-1</sup>), and syntanol DS-10 (1.5...3 g L<sup>-1</sup>). Optimal degreasing regime: pH = 6.0...6.6, t = 60...70 °C, τ = 10...15 min. The application of ultrasound with a frequency of 20...80 kHz improves the process. In the presence of a chemical polishing operation, it was proposed to exclude the preliminary activation in a mixture of 200 g L<sup>-1</sup> HCl and 10 g L<sup>-1</sup> HNO<sub>3</sub> from the technological process. Experiments showed that this did not lead to an increase in rejects.

Replacing a hot (50 – 60 °C) chemical polishing solution of H<sub>2</sub>SO<sub>4</sub> (350 g L<sup>-1</sup>), H<sub>3</sub>PO<sub>4</sub> (550 g L<sup>-1</sup>), NH<sub>4</sub>F (40 g L<sup>-1</sup>) with a cold (20...25 °C) solution of HNO<sub>3</sub> (450...500 g L<sup>-1</sup>), NH<sub>4</sub>F·HF (100 g L<sup>-1</sup>), H<sub>2</sub>SiF<sub>6</sub> (70...90 g L<sup>-1</sup>) saved more than 5700 kWh year<sup>-1</sup> of electricity without compromising quality.

Replacing the titanium alloy anodic oxidation electrolyte (60...80 g L<sup>-1</sup> oxalic acid) with other electrolytes (150...180 g L<sup>-1</sup> H<sub>2</sub>SO<sub>4</sub> or 80...100 g L<sup>-1</sup> sulfosa licylic acid) led to negative consequences. In our opinion, an equivalent substitute for oxalic acid anodizing was anodizing in a cheaper electrolyte containing 45...55 g L<sup>-1</sup> H<sub>3</sub>PO<sub>4</sub>.

The use of the anode-spark anodizing method and the application of a hydroxyapatite layer on the surface of titanium implants at this stage had to be abandoned for various reasons. The research revealed an improvement in the corrosion resistance of anodized titanium products as a result of their exposure to hot (80...85 °C) water for 2..3 minutes.

The changes introduced into the anodizing process made it possible to increase the productivity, as well as to reduce specific material, energy and operating costs, and ultimately lowered the overall cost of the titanium alloy anodizing process.

### References:

1. Електрохімічне оксидування медичних імплантатів, виготовлених з титанових сплавів / Т.М.Масляк, Д.Д.Білобородов, С.А.Лещенко // Інформаційні технології: наука, техніка, технологія, освіта, здоров'я = Information technologies: science, engineering, technology, education, health : тези доп. XXXI міжнар. наук.-практ. конф. MicroCAD–2023, 17-20 травня 2023 р. / за ред. проф. Сокола Є. І. – Харків : НТУ "ХПІ", 2023. – С. 582.