Synthesis of a Ta-rich PEO-coating on AISI 304 stainless steel for potential use as biomaterials

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SUMMARY

Austenitic AISI 304 stainless steel is a metallic material often used in medical and dental appliances, due to its low cost, adequate mechanical strength, and biotolerability in the human body. However, its use as biomedical implants requires greater corrosion resistance to avoid the release of ions or debris, which could cause allergy, inflammation, or failure. One way to overcome this drawback is by coating the surface with ceramic oxides, which can protect against corrosion reactions [1]. Through the process of plasma electrolytic oxidation (PEO), it is possible to create an oxide layer strongly adhered to the metal surface. Having into account the high corrosion resistance of Ta-based oxides [2,3], this study aimed to produce a Ta-rich coating on AISI 304 samples, by using PEO treatment, targeting the use for biomaterials. The PEO treatment was carried out in a stainless steel reactor with internal water cooling. The samples were placed at a negative potential (anode), while the stainless steel chamber was kept at a positive potential (cathode). The surface treatments were carried out with a pulsed voltage source, with voltages of 200 V, frequency of 1000 Hz, a duty cycle of 60%, during 10 min. The electrolyte was varied, consisting of an aqueous solution of potassium hydroxide (KOH; 2, 2.5, and 3 g per liter) and tantalum hydroxide (TaOH; 10, 30, and 50 g per liter). The treatments were carried out in triplicate, to ensure good reproducibility of results. Then, morphology, phase proportion, and chemical composition

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were evaluated by SEM/EDS, profilometry, wettability, and XRD measurements. During the first minute of treatment, it was possible to see a sharp current rising due to the KOH electrolyte. After that, an exponential current decay proved that an oxide layer was formed on the substrate surface, which hindered the passage of current and favored the appearance of plasma micro-arcs. SEM/EDS results indicated that the oxide layer was porous, with some amount of Ta oxide incorporated into the coating. The XRD pattern exhibited just an amorphous phase composition, having effects on the wettability and roughness values. (Financial support: CNPq and FAPESP)

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