VANADIUM OXIDE RICH NANOTUBES ON BOTH PHASES OF ANODIZED Ti6Al4V ALLOY

Agnieszka Kaczmarek, Katarzyna Arkusz, Elzbieta Krasicka- Cydzik

University of Zielona Gora, Mechanical Department
9 Licealna Str, 65-417 Zielona Gora, Poland
MAILTO:a.kaczmarek@ibem.uz.zgora.pl,

Abstract

Ti6Al4V, if used as an implant material is becoming replaced by other titanium based medical alloys due to the toxicity of vanadium. Anodic modification carried out to obtain nanoporous structures on this two-phase material leads to the formation of oxides only over α phase, vanadium rich β phase oxide being etched [1,2] due to the high solubility of V-oxides. However, vanadium oxides having excellent conductive [3,4] and catalytic [5] properties, with ability to bind proteins [6] and similar to phosphates in the metabolic affinity to insulin mimics [7]. Such properties are prospective for using anodised nanotubular layer of the Ti6Al4V as a biosensor platform. Anodizing the Ti6Al4V alloy in phosphoric acid with fluoride ions gives nanotubes presented in Fig.1a, whereas using 99.0% ethylene glycol with 0.6% fluorides leads to formation of uniform 50nm diameter nanotubes on both phases Fig.1b. To next experiments for thermal modification and electrochemical examination the most appropriate surface was obtained during anodization in 99% ethylene glycol with 0.6% of NH_4F in 20V during 20min. Thermal modification was carried in 600^{0}C in three atmospheres (air, argon and nitrogen), only modification in nitrogen does not affect on the nanotubes morphology, in other cases shape and nanotubular character of oxide layer changes to nonregular oxide structures. Corrosion potential, cyclic voltametry and EIS studies carried in PBS solution for each of thermally modified oxide surface confirmed unique electric properties of obtained layers. Obtained novel coating with nanotubular TiO_2, Al_2O_3, and VOX and their conductive, biological and catalytic properties may be a bioactive and cell growth stimulating layer, a platform for high sensitive sensors, or nanodimensional electrode material.

[Engineering of Biomaterials, 116-117,(2012), 155]

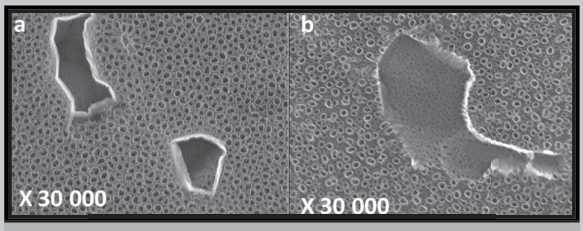

FIG. 1. Surface of Ti6Al4V after anodization in 1M H_3PO_4 +0.3% HF (a), ethylene glycol+1% H_2O+0.6% NH_4F(b).

References

[1] Macak J.M., Tsuchiya H., Taveira L., Ghicov A., Schmuki P., J. Biomed. Mater. Res. 4 (2005) 928-933.
[2] Luo B., ang H., Liu S., Fu W., Sun P., Yuan M., Zhang Y., Liu Z., Mat. Lett. 62(2008) 4512-4515.
[3] Yang Y., Kim D., Schmuki P., Electrochem. Comm. 13 (2011) 1198-1201.
[4] Yang Y., Kim D., Schmuki P., Electrochem. Comm. 13 (2011) 1021-1025
[5] Wang Y., Zhang Z., Zhu Y., Li Z., Vajtai R., Ci L., Ajayan P.M., ACSNano 7 (2008) 1492-1496.
[6] Gannon G., O'Dwyer C., Larsson J.A., Thompson D., J. Phys. Chem. B., 115 (2011) 14518-14525.
[7] Rehder D., Bioinorganic vanadium chemistry, John Willey & Sons 2008.