Nanostructured surfaces

Microstructure and corrosion resistance of biomedical Ti6Al4V alloy modified by complex ultrasonic impact treatment

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Titanium alloys, have a wide range of applications owing to their high strength-to-weight ratio and good corrosion resistance. At the same time, the surface properties of titanium alloys, such as corrosion and wear, need to be enhanced for their safe use as materials for biomedical implants.

Present work is aimed to modify the surface layers of biomedical Ti6Al4V alloy by means of combined surface alloying and nanostructuring. The effects of the electric discharge surface alloying (EDSA) with alpha titanium followed by ultrasonic impact treatment (UIT) on the microstructure and hardness of the surface layers are studied using X-ray diffraction (XRD) analysis, scanning electron microscopy (SEM) and transmission electron microscopy (TEM). Additionally, the corrosion behaviors of the Ti6Al4V alloy are analyzed using potentio-dynamic measurements in saline solution.

The surface layer of hcp-titanium deposited by EDSA is firmly connected to the underneath Ti6Al4V alloy substrate. It underwent nanostructuring during severe plastic deformation induced by UIT [1]. TEM analysis shows that the outmost surface layer of ~20 μm thick comprises the nano-scale grain structure with an average grain size of about 10-30 nm. Additionally, the mechanochemical oxidation [2] of the alloy top surface was observed by SEM and energy dispersive X-ray microanalysis.

The nanostrucutred surface layer of alpha titanium on the biomedical Ti6Al4V alloy shows enhanced microhardness and corrosion resistance in saline solution, and the complex treatment applied can be recommended for the surface finishing of biomedical implants made of multi-phase titanium alloys.

1. *Mordyuk B. N., Prokopenko G. I.* Ultrasonic impact treatment – an effective method for nanostructuring the surface layers of metallic materials // in: Handbook of Mechanical Nanostructuring, Wiley-VCH.- 2015.- P. 417-434.

2. *Vasylyev M. A., Chenakin S. P., Yatsenko L. F.* Ultrasonic impact treatment induced oxidation of Ti6Al4V alloy // Acta Mater.- 2016.- **103**.- P. 761-774.