Properties of nanotitanium for potential medical applications

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Ultrafine grained and nanocrystalline materials exhibit attractive properties such as high strength combined with sufficiently good ductility. These materials can be obtained using the various methods of severe plastic deformation (SPD). Fabrication of bulk nanostructured materials by SPD is becoming one of the most actively developing areas in the field of nanomaterials [1-4].One of the methods which enable high plastic strains is hydrostatic extrusion (HE). HE offers the potential for producing homogeneous, fully dense bulk nanometals such as aluminium alloys, nickel and titanium [5-8].

Pure titanium is biocompatible with human fluids and tissue. However, in the coarse-grained form it has too low yield point for the fabrication of implants. TA6V alloy, which is widely used for medical applications, is two times stronger than pure titanium. However, the vanadium and aluminium atoms in this alloy reduce its biocompatibility. In the present work HE was used to obtain nano-grained titanium strengthened by grain boundaries to the level higher than conventional TA6V.

Titanium rods were subjected to multistage hydrostatic extrusion. This study reports the results of investigations of mechanical properties and corrosion resistance of pure Ti-Grade 2 after hydrostatic extrusion. The microstructures of the materials before and after HE were observed using light microscopy and TEM. It has been found that the HE process results in a substantial refinement of the titanium microstructures. The titanium rods after HE had the average grain size of about 90nm. The refinement of the microstructure is accompanied by the improvement of mechanical properties, such as microhardness and tensile strength, at the same time, good plasticity it preserves. The tensile strength of the obtained nanotitanium was 1000Mpa, microhardness 273HV0.2 and elongation about 10%.

The investigations of the corrosion resistance of the titanium in as-received state and after HE were carried out in NaCl solution. The surface microstructure after corrosion tests was survey using SEM. The results revealed that the nanotitanium undergoes uniform corrosion. On the surface of the investigated samples no zones of pitting corrosion were observed. The obtained results showed that the corrosion resistance of the nanotitanium is as good that of the titanium with micrograins.

Keywords: nanotitanium; mechanical properties, corrosion resistance