STUDY OF THE TINI-BASED POWDER ALLOY SURFACE BY NON-DESTRUCTIVE TESTING METHODS *

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As a rule, in order to gain access to the developed internal structure of the porous material, it is necessary to carry out preliminary cross breaking of the porous sample. Stress fields and cracks can distort the surface structure of the pore walls, and due to the volumetric developed structure of the porous material not always research can be undertook. To solve this problem, the task was set of obtaining two-dimensional porous samples with a similar structure to the porous body of the TiNi-based alloy. For this purpose, hydride-calcium TiNi-based powder was placed on TiNi-based monolithic plates and sintering was carried out under similar conditions to obtain porous TiNi-based alloys. Due to this, it became possible to create an identical structure of the porous body obtained by diffusion sintering. This approach is effective in studying the surface morphology of a material using scanning, transmission, atomic force microscopy, and profilometry without preliminary sample preparation procedures that could potentially distort the results of the study. The objective of this work is to develop a TiNi-based powder alloy obtaining method for the use of non-destructive methods of studying the state of the surface of a material.

Samples were obtained by a single diffusion sintering method at a temperature in the range of 1240–1260 ° C and a sintering time of 15 min. The powder was placed on the plate and evenly distributed on its surface in such a way as to prevent the appearance of layer discontinuity. The thickness of the powder layer was about 300–350 μm, which corresponds to the size of 1–2 particles of TiNi-based powder. The macro- and microstructure of the obtained samples was studied by scanning electron microscopy using a Quanta 200 3D system with electron and focused ion beams with an integrated EDAX ECON IV energy dispersive spectrometer. X-ray diffraction studies were conducted on a Shimadzu XRD 6000 X-ray diffractometer. Building of the three-dimensional surface reconstruction and determination of roughness parameters were performed using an interference microscope of the MNP-1 profilometer using the software of the same name.

Leading of the used sintering mode to the homogenization of the TiNi-based powder alloy was established. X-ray diffraction analysis confirmed the presence of the austenitic phase TiNi (B2), Ti_3Ni_4, Ti_2Ni and Ti_4Ni_2 (O, N, C) in the composition of the obtained TiNi-based powder alloy. The obtained result is explained by the structure of the initial powder materials, which contain a TiNi intermetallic compound in a two-phase state – B2 (austenite) and B19' (martensite), and phases enriched with titanium Ti_2Ni, as well as traces of nickel-enriched phases — $TiNi_3$ and metastable phases Ti_3Ni_4.

On the surface of the material obtained by diffusion sintering, an amorphous layer of titanium oxide TiO_2 is formed in the rutile modification with a thickness of about 40-60 nm. In the structure of the surface layer the globular shape of particles that form the surface layer with a thickness of 20–30 nm can be distinguished; the structure of the substance in this layer does not differ from the main layer. It is known that during the formation of the oxide layer, it is possible to delaminate and separate into sublayers with different structures. Due to the presence of surface layers of titanium oxide, the corrosion properties of a material TiNi-based increase and when interacting with tissue media in the human body, the surface layer of TiO_2 promotes the adhesion of proteins and osteogenic cells.

Many individual TiNi-based powder adhered to the surface of the monolithic plate particles constitute the structure of the obtained sample. Variation of the temperature-time modes of diffusion sintering can make it possible to obtain a material with an increased roughness index R_a when a TiNi-based powder alloy is used. A high value of the latter can positively affect the adhesive properties of the implant material, which has a developed surface.

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