USING OF NANOCRYSTALLINE ZIRCONIA CERAMICS FOR MANUFACTURE INTERVERTEBRAL JOINT PROSTHESIS IN SURGICAL TREATMENT OF DAMAGES OF CERVICAL DEPARTMENT OF A VERTEBRAE

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In a modern surgery the different types of biomaterials including ceramics are widely used. In comparison with other materials, ceramics is most compatible with an organism, weakly influences on the immune system and has a wide range of biochemical, mechanical and other properties. Despite of wide experience of use of ceramics, its application remains circumscribed because of fragility and low strength. Therefore ceramics is used for manufacture of surgical implants which do not expose to large bending loads.

The application of new high-strength nanocrystalline zirconia ceramics essentially expands opportunities of surgery [1]. The aim of the research is the development of spinal implants: intervertebral joint prosthesis and screws from zirconia ceramics.

The prosthesis on a design similar to [2] were made of ceramics based on yttria-stabilized tetragonal zirconia. The prosthesis design and material provides reliable attachment to vertebral bodies. The articles made on powder technique with use of cold isostatic pressing as a preforming operation [3]. The shape of compacts was as much as possible approached to the shape of ready articles. In result the additional machining of articles was minimum. It has allowed avoiding occurrence of defects at mechanical operation. Due to using of cold isostatic pressing the compacts with homogeneous microstructure that ensures sintering of high-performance structural ceramics were produced. The material of implants meets the requirements of the standard ISO 13356 [4]. The clinical application of zirconia implants is applied at 11 patients with damage of a cervical department of vertebrae.

The zirconia ceramics is a non-carcinogenic, bioinert material with high strength. It allows to reduce the size of implants and to lower traumatism of operation. The high strength of this ceramics allows using it for manufacture of surgical implants and prosthesis exposed to large bending loads.

[1] Piconi C., Maccauro G. Zirconia as a ceramic biomaterial // Biomaterials.-1999.-Vol. 20.- P.1-25.

[2] Chayka E.V. , Chayka V.A., Bublik L., Mityushin I.I. Movable prosthesis intervertebral joint prosthesis / Ukrainian Patent No 10138. 2005. Bull. No11 ().

[3] Chayka E.V. , Chayka V.A. Method of isostatic compression of powder compacts / Ukrainian Patent No 53206A. 2003. Bull. No1.

[4] ISO 13356:2008(E) Implants for surgery - ceramic materials based on yttria-stabilized tetragonal zirconia (Y-TZP).

KINETICS OF NONSYMMETRICAL SEGREGATION OF AN IMPURITY AT THIN METAL FILM BOUNDARIES

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The peculiarities of segregation of impurities at the boundaries of a thin layer of substance separating two different solid materials are analyzed. Because materials outside the layer are different, the motion of an impurity toward the boundaries is not the same, depending on energy characteristics of the impurity within the bulk of the thin layer and at the boundaries.

Impurity segregation in a limited volume with respect to the specific form of impurity-containing material have already been considered more than once both in theoretical and experimental papers. As a rule, it was supposed that the surrounding of a grain or a film containing a segregating impurity is the same in all directions. Adequately, it can be true for impurity segregation at grain boundaries in bulk metals but now film structures are of great interest, where the layer of solid solution is of low thickness (about several microns) and surrounded by different materials. The simplest example is a film on a substrate with the second surface left free. More often, the samples are of multi-layer structure. Besides, the accumulation of residual impurities at the interfaces of industrial film objects often influences the mechanical properties of the devices (e.g., chromium segregation in copper films enhances its adhesion)

Here, theoretical analysis and calculation of kinetics of impurity redistribution within the film and at the boundaries has been carried out with respect to the values of energies of lateral interaction of impurity atoms. The time dependences of boundary impurity concentrations and concentration profiles within the film have been obtained. Depending on the energy of impurity interaction with the boundaries, lateral interaction and the temperature, some criteria were established to predict probable realization of segregation process. The estimations of time of exhausting of areas adjusting segregation layers have been carried out as well as the width of the exhausted zone near the boundaries. The calculation of time dependences of impurity accumulation within the segregation layer were carried out for materials used often industrially, e.g. copper,

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