Bearing pair 'sapphire/nanostructural zirconium dioxide' for total hip-joint prosthesis of the person and technology of its making

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Problem Description

The durability of total hip-joint prostheses is serious restriction of their use, and depends on wear resistance of bearing pair which is formed by a convex spherical surface of ball head and a surface of a hollow of the same form in acetabular cup. For today total hip-joint prostheses with metal-metal or ceramic -ceramic pair have maximal operation life. Use of metal-metal pair is limited by release of toxic ions of cobalt, chrome because of wear process. A disadvantage of the ceramic material is low crack growth resistance (leads to product destruction) or insufficient long-term stability (influences on wear of interfaced surface), a ceramic composite eliminates this disadvantage only partially.

The way of problem solving

Bearing pair 'sapphire/nanostructural zirconium dioxide' is offered to application in total hip-joint prostheses of the person. Unlike polycrystals sapphire is single crystal. Therefore it has no harmful impurity in intercrysalline space. Its wear resistance is the highest between friction pairs. Simultaneously it is one of the best biologically favorable materials - it is not toxic, does not change the general reactance of a live organism, does not lead to influences of the remote action, shows biological activity - promotes growth of a bone tissue on its surface. Use of acetabular cup or inlay for it from sapphire in bearing with ball head from nanostructural zirconium dioxide raises a biological compatibility, wear resistance of bearing pair, which is in 1,5 times above, than at bearing pair sapphire/sapphire. The technologies of diamond machining are offered to form precision surfaces with accuracy of the form <1 micron. Except medical application a couple of the materials is expedient for using in stop valve in transportation systems for a liquid foodstuff (milk and liquid products of its processing, wine, a limy solution at sugar manufacturing, etc.).

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Making of ball head from nanostructural zirconium dioxide

Making of an inlay for acetabular cup from sapphire

Basic publications

1. Joint endoproteses of the person: materials and technologies / Edited by Prof. M.V. Novikov, Prof. O.O. Rozenberg, Prof. J. Gawlik / M.V. Novikov, O.O. Rozenberg, J. Gawlik, S.V. Sokhan and all. – Kyiv: ISM NASU, 2011. – 528 p.

Innovative Aspects of the solution / development/ methodology, tool, prototype

Сила трения в предложенной паре в 1,3 раза ниже, а износостойкость – в 1,5 раза выше, чем у пары сапфир/сапфир.

Main advantages of the solution / development/ methodology, tool, prototype

In comparison with bearing pair from composite ceramic materials as the best for today, bearing pair 'sapphire/ nanostructural zirconium dioxide' is chemically inert, electrically neutral, thanks to sapphire has the raised wettability, biological compatibility (activity), promoting growth of a bone tissue on a surface of sapphire which besides has no harmful impurity in intercrysalline space.

Financial and Economic Parameters

As Ukraine possesses industrial production of sapphire, perspective ceramic materials for medical use, application of these materials will allow to raise durability and to lower the manufacturing cost price of total hip-joint prostheses. Offered bearing pair can be adapted for a design serial total hip-joint prostheses or import production.

Current stage of development of the offered solution / development/ methodology, tool, prototype *(please, select)*

● Development phase – laboratory tested
○ Available for demonstration – field tested
○ Already on the market
Comments:

Intellectual Property Rights *(please, select)*

○ patent applied for (name countries in which you have applied for patents in)
○ patents granted (enter the countries that have granted the patents; where the initial patent was granted and say a few words about the company)
● copyright
○ exclusive rights
○ secret know-how
○ others (registered design, plant variety right, etc.)
Comments

Collaboration Details (Type of collaboration sought; *more than one option can be selected*)

● Technical co-operation
○ Commercial agreement with technical assistance
● Joint Venture agreement
○ License agreement
○ Manufacturing agreement
● Financial resources
Comments:

Technology Key words

total hip-joint prostheses, bearing pair of sapphire/ nanostructural zirconium dioxide, precision surfaces, diamond machining