

FORMING AND MODIFICATIONS OF PURE TITANIUM SURFACES OF SPHERICAL HEADS FOR HIP HUMAN JOINT

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Problem Description

It is known that from technical and biological points of view alloys based on CoCrMo and titanium are best for endoprostheses.

However, the CoCrMo alloy is not the best material in biocompatibility. According to the clinical research, the alloy components are revealed in patients internals. The question if getting into the blood they cause kidney damages and allergic reactions is under discussion [1].

A replacement of a metal with ceramics can reduce wear of joints; however, the disadvantage of ceramics is increased fragility, which may result in the destruction of ceramic components under dynamic loadings (e.g., installing head or falling of the patient).

When choosing the materials for the manufacture of implants one should also consider the material biocompatibility with a human body. Metal alloys containing vanadium, aluminum, cobalt, chromium, cadmium, and carbides as well as carbon steels are toxic, while titanium does not cause allergic reactions.

Based on this, to produce endoprosthesis hip joints that meet the modern requirements, the most appropriate is the use of pure titanium, provided that its service characteristics are increased to the level of doped Ti (grade 5).

However, due to the low mechanical characteristics and increased tendency to seizing with almost all structural materials used in medicine, the application of pure titanium friction couples without modification of the friction surface is not possible.

Way of solving problems

Thus, the successful solution of a low-cost, corresponding to modern requirements of hip endoprosthesis is possible after the decision of a complex technological problem, which can be divided into the following stages:

- Getting accurate shape of a product and a low roughness of the working surface in accordance with GOST R ISO 7206-2-2005 by methods of machining;

- Modification of the working surface of the product, which provides an optimal combination of mechanical properties and adhesion of inert;

Key publications of the Department on the subject:

1. Sheykin S.Ye., Rostotskyy I.Yu., Iefrosinin D.E. Development of the process of the precision machining of spherical titanium heads of hip-joint endoprostheses of the person and enhancement of their life. / "Mechanika w Medycynie", odbeda sie w Rzeszowie - Boguchwale w dniach 13 - 14. IX. 2012 r.s.159-165

2. Sheykin S.Ye., Rostotskyy I.Yu., Iefrosinin D.E., Rutkovskii A.V., Bondar V.K. Improvement of the service-ability of titanium-chirulen friction couples./Materials Science: Volume 48, Issue 1 (2012), Page 113-118

3. S. Sheykin, V. Bondar, D. Efrosinin, I.Rostotskyy Spherical head of articulatoin for pure titanium hip joint of endoprosthesis./ 10th Congress of theEuropean Hip Society P#151

4. A.V.Grushko, S.E. Sheykin, I.Yu. Rostotskyy Contact pressure in hip endoprosthetic swivel joints./ Journal of Friction and Wear, 2012, vol.33, No.2 pp.124-129

5. S.Ye. Sheykin, I. Yu. Rostotskyy, D.V.Iefrosinin On Performance of Pure Titanium in the Titanium–Chirulen Friction Pair, / *Visoki tehnologii v mashinobuduvanni: Collection of Scientific Papers*, - Харків, NTU "KhPI", 2011, issue 1, pp. 274–28. 2011.

Innovative aspects of the solutions / development / methodology, tools, prototype

We are the first to propose a comprehensive technology solution that improves the service characteristics of the working surface of endoprostheses head of pure titanium. The technology is based on the use of intensive surface plastic deformation and thermal diffusion nitriding, which ensures the formation of structural and phase conditions of the modified surface layers with required properties.

For the efficient formation of spherical products diamond composite materials with polymer binders have been developed, which are capable of adaptive variation of the elastic modulus. This feature shows up in continuous rearrangement of the tool working surface topography.

The main advantages of the solution / development / methodology, tools, prototype

As is known, pure titanium exceeds other metals and alloys in biocompatibility with a human body. However, its use is limited by the poor machineability and tribological characteristics. Due to studies conducted at the ISM, we have managed to solve these problems. To date technologies for precision machining of pure titanium heads, pure titanium surface modification and deformation of pure Ti spherical product are developed.

Financial and economic indicators

Taking into account the special features of technology, the overhead and cost of materials and tools, the price of a pure titanium head is \approx 100 USD (according to various international manufacturers, the cost of a head of CoCrMo, is, on the average, 350 USD).

Current stage of development of the proposed solutions / development / methodology of the tool, the prototype (please select)

Development phase - laboratory tested Available for demonstration - field tested

Already on the market Comments:

Intellectual property right (please)

patent applied for (name of the country in which you have applied for a patent)

granted patents (enter the country to obtain a patent, which began patent was granted and say a few words about the company)

copyright

exclusive rights (exclusive)

secret know-how

Others (registered design, plant variety rights, etc.)

Comments: V.N. Bakul Institute for Superhard Materials, Patent of Ukraine 75753 Composition for Making Abrasive Tools, issued 10.12.2012. The patent describes a composition for the manufacture of tools for precision machining of pure titanium products.

More cooperation (Type of collaboration, more than one option can be selected)

Technical cooperation Commercial agreement with technical assistance-sky

joint venture agreement License Agreement

Manufacturing agreement financial resources

Comments:

Technology sector

Prosthesis, titanium, biocompatibility, cold surface plastic deformation, coating, adhesive inertia