EU and Russian scientists join efforts in development new nanomaterials for medical implants

With the ageing of European population, more and more people find themselves in need of dental or bone implants, which should help them to continue normal life even after mechanical damage or medical operations.

The first project meeting of European project "Virtual Nanotitanium" in Risø Campus, Roskilde: representatives of DTU, Goethe University Frankfurt, Materials Institute Spain, Technion and a company Timplant.

The implants should remain functional over dozens of years without any deformation, and also without producing any toxic substances in the body. Titanium is a rather strong material, with high biocompatibility, and is therefore one of the most promising materials for medical implants in trauma surgery, orthopedic and oral medicine.

However, dental and bone implant are subject to the very high loads. That is why even higher strength and damage resistances that those of common titanium are required to ensure the necessary service properties.

Project general meeting. Welcome speech by Coordinator. From left: Dr. Leon Mishnaevsky Jr. (EU Coordinator), Prof.. Evgeny Levashov (Russian Coordinator), Elena Gruzinova, Head of Dept of Russian Ministry of Education and Science

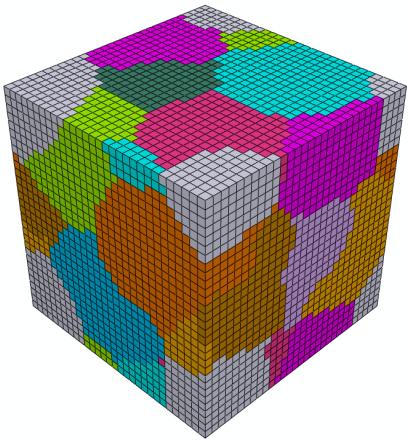
The very promising way to improve the implant materials and to ensure the required properties lies in **nanotechnology.** Applying the severe plastic deformation to metals, one can obtain new materials with very small grains (so-called ultrafine grained metals), which have also superior properties. These nanostructured materials are stronger and also more durable than common metals, and thus, they can serve best as materials for implant applications.

In order to develop nanostructured materials for medical implants, which correspond exactly to the service requirements, scientists and developers widely use computational models.

To develop the models and software for computational development of materials for implants, several group of European and Russian scientists joined their efforts in two coordinated projects, funded by European Commission (Framework 7 Program) and Russian Ministry of Education and Science. The research project “Virtual Nanotitanium”, coordinated by the Technical University of Denmark, has been started in 2011. Research groups from Denmark, Belgium, Germany, Spain, Czech Republic and Israel as well as 6 groups from Russia participate in the project, covering different aspects of the development and computational modeling of nanomaterials.

During the project, several new technologies, computational models and implant prototypes have been developed.

A software complex for multiscale virtual testing of nanotitanium for the strength, usability in biomaterials and lack of toxic materials has been developed. This software can be then used by companies developing the new implants and materials, to optimize the materials and technologies.



Schema of crystal plasticity model of nanotitanium (IMDEA Spain)

A novel processing route for fabrication of nano-titanium, based on high temperature ECAP-C (equal-channel angular pressing) processing and drawing, was developed by Russian partner, Ufa State Aviation Technical University.

Prototype of nanotitanium based small radius dental implant (Timplant)

A further practical result is the development, fabrication and testing of new nanotitanium based implants with lower diameter, which can withstand loads similar to those carried by implants of conventional design with a 50% larger diameter made from coarse-grained Ti. The implant is made from pure Ti, and doesn’t contain any toxic alloying elements or allergens. The prototype was developed by the Czech project partner, small company Timplant.

In the framework of the project, a special issue of the international journal “*Computational Materials Science*” was published, and an International Conference on Computational Modelling of Nanostructured Materials is organized in Frankfurt am Main, Germany.

Dr. Leon Mishnaevsky Jr, Senior Researcher at Technical University of Denmark and Coordinator of the EU project,. noted that the application of developed computational models would allow efficient, reliable and quick development of nanomaterials for medical implants, thus, minimizing the necessity in animal tests. Further, the developed tools and technologies will open new possibilities in trauma surgery, orthopedic and oral medicine, allowing to heal bone illnesses, dental problems, and traumas at a new level.

The coordinator of the Russian project, Professor Evgeny Levashov (National University of Science and Technology "MISIS", Moscow) underlined that this work is a very positive example of collaboration between European and Russian research teams, leading to the excellent new results.

The Technical Advisor of the project, Professor Eberhard Seitz (Clausthal University of Technology, Germany) noticed that the main results of this project, the software for the optimization of nanomaterials for implants and the small radius implant, will surely attract interest of industries.

The project participants agreed to sign the memorandum of understanding lying ground for future collaboration and project continuation. In the Memorandum, the partners “agree agree to continue scientific, technical and practical collaboration in the area of the project” and related areas, among them, other nanostructured materials, their computational modeling and virtual testing of nanostructured materials.

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Links:

Project webpage at DTU

Project webpage at European Commission

International Conference on Computational Modelling of Nanomaterials, Frankfurt, 3.-6.9.2013