Subarea POB3: Advanced methods of material surface modifications.

Title of the presentation: Hybrid surface modification of Ti6Al4V titanium alloy and laser superficial fusion of gold nanoparticles with PEEK polymer

Authors:

mgr inż. Anna Woźniak, RMT, anna.wozniak@polsl.pl, Materials Research Laboratory, Faculty of Mechanical Engineering
mgr inż. Oktawian Bialas, RMT, oktawian.bialas@polsl.pl
mgr inż. Mateusz Lis, RMT, mateusz.lis@polsl.pl
dr hab. inż. Marcin Adamiak, prof. PŚ, RMT, marcin.adamiak@polsl.pl

Abstract:

Titanium and its alloys have been regarded as inert and biocompatible materials with good corrosion resistance. Nonetheless problems related to maintaining proper condition of the area of contact between tissues and implants surface are still actual. In order to minimalize the toxicity reaction, the surface micro-and nanoscale modification could be performed. Obtaining functional titanium implants with better properties is possible as a result of surface modification by the Atomic Layer Deposition ALD method of thin coatings deposition. The use of inorganic oxide layers in biomedical applications has attracted interest due to their high chemical stability, satisfactory biocompatibility, and possible high antibacterial potential However, the surface topography in microscale is also an important factor, which could affect the cellular response. General, the larger the effective (real) surface area provides the higher is the degree of adheres of bone-to-implant - positive relation between surface roughness and implant anchorage strength. Additionally, as a result of laser ablation, the formation of titanium oxide on the surface of the Ti6Al4V alloy material is intensified, which is a barrier against corrosion damage. Realized work aimed to investigate the influence of hybrid coating (ALD method – laser texturing) on the chosen properties of the titanium alloy Ti6Al4V, obtained by selective laser melting.

According to WHO data, the leading cause of death worldwide is cardiovascular failure. This condition imposes the need to improve materials used in cardiovascular applications in order to reduce reoperation rates and mortality, especially in the short period after implantation of a foreign body into the system. Surface structuring by applying monochromatic light as a very advantageous method is intensively studied, due to its high precision and flexibility in terms of creating different structures and changing the morphology and chemistry of the surface. Current research focuses on modifying the material with a laser beam by depositing Au particles and reducing their size to the nanoscale by top-down methods. The novel material polyetheretherketone (PEEK), which tends to be chemically stable and has the potential to be used as an alternative to titanium alloys conventionally used for implantation. The PEEK polymer has been enriched with gold nanoparticles in the form of a 200 nm thick layer selectively ablated/melted onto the material surface. Au nanoparticles are widely used as markers in X-ray, computed tomography or magnetic resonance imaging. And they may find

application for cardiovascular devices to assess the position of a polymer implant after implantation and to control material degradation in the long term due to gold's high biocompatibility. Antimicrobial properties are also extremely important as a potential reduction of the risk of implant rejection in the early postoperative stage due to the occurrence of bacterial infection.