SUMMARY

Additive manufacturing is a method that provides design flexibility compared to traditional machining technologies. Moreover, it enables production without the need for traditional techniques such as casting, forging and machining. DMLS is one of the widely used additive manufacturing methods and works by sintering layer upon layer of powder applied to a work plate. Among other things, this technology makes it possible to produce parts from titanium Ti6Al4V alloy. This alloy is well known to be characterized by high strength while maintaining low weight of finished products and very good corrosion resistance, which made it applicable in aerospace, automotive, nuclear, robotics and biomedical implantology components. However, the insufficient tribological properties of titanium, especially the mechanism of fretting wear, creates the need to modify the surface layer in order to increase the durability of the elements produced in this way. Recently, it seems optimal to use thin ceramic coatings with high hardness and antiwear properties for this purpose.

As it is known from the literature data, the laser-sintered Ti6Al4V alloy has different properties of the surface layer in comparison with the alloy made in a conventional metallurgical process. Such parameters include mainly the geometric structure of the surface, microstructure including texture, phase composition, stresses in the surface layer, or mechanical properties such as nano-hardness and elastic modulus. Therefore, it was decided to investigate the effect of different properties of laser sintered alloy on the performance and suitability of thin PVD ceramic coatings.

Accordingly, the scientific objective of this research was to determine the relationship between the microstructure, morphology and mechanical properties of the surface layer of the laser-sintered Ti6Al4V alloy and the adhesion and tribological properties of selected ceramic coatings.

The utilitarian goal is to demonstrate that the technology for fabricating Ti6Al4V alloy by direct laser sintering of DMLS powder is feasible for the fabrication of machine nodes such as humanoid robot joints and roots of turbine engine blade, and that the use of thin ceramic coatings leads to increased durability of the laser-sintered titanium alloy-ceramic system.

It was possible to achieve these goals by proving the following thesis:

The state of the titanium alloy surface layer after DMLS laser sintering does not significantly affect the tribological properties of ceramic nitride coatings, but improves their adhesive properties.

The scope of the research of this work included two Ti6Al4V alloy substrates made using different technologies and the properties of three thin ceramic coatings AlTiN, TiAlN, TiSiN. The following tests were carried out on the samples in the form of discs: profilometry tests, numerous SEM analyses, nanoindentation tests, stress-strain analysis of the second kind and phase composition analysis, microstructure analysis, scratch, wear resistance tests by friction in the ball-disc association.

The research has shown, in many cases, better adhesion properties of thin ceramic coatings applied on laser-sintered titanium alloy than on conventional one. The conclusions stated, among others, that the ceramic coatings analyzed can be successfully applied on sintered titanium alloy Ti6Al4V in order to protect friction nodes with complex shape geometry against wear by friction. They can also successfully replace components produced by conventional methods. This is important especially for titanium products when some shapes cannot be achieved by conventional technologies, e.g. unusual curvatures of roots of turbine blades prone to fretting.