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PRACA DOKTORSKA

Wytwarzanie kompozytowych warstw powierzchniowych na podłożu tytanu GRADE 1 metodą laserowego wtapiania proszków żelazo-niklu i żelazo-chromu

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Titanium and its alloys belong to the group of materials commonly used in the chemical, energy, automotive, shipbuilding and aviation industries. Such a wide range of applications results from the unique properties of titanium, i.e. high specific strength, low density and high thermal stability. Titanium is also characterized by high biocompatibility and corrosion resistance, which results from the ability of titanium and its alloys to self-passivate, i.e. the spontaneous formation of an oxide layer on its surface.

Pure titanium and titanium alloys are characterized by relatively low wear resistance and a high coefficient of friction. The reason for this state is primarily the crystal structure of this group of materials and the low tensile/shear strength of the oxide layer formed on their surface. The above features largely verify the applicability of titanium in conditions of intense abrasive wear.

The improvement of tribological properties of titanium and its alloys can be obtained by using laser treatment, which has become much more popular over the last several years. Its use can ensure disintegration, homogenization, hardening of the microstructure, change of chemical composition, improvement of mechanical and/or physical properties. Rapid cooling of the molten material allows to obtain a surface layer with mechanical and physicochemical properties different from the parent material, often also ensuring an improvement in the operational properties of the processed element. Modern solutions in the field of laser treatment of titanium alloys focus on the use of β phase stabilizing elements (eg Fe, Cr, Ni, etc.).

In this paper, it was undertaken to determine the effect of laser fusion of Fe-Cr, Fe-Ni particles additionally with the use of two different laser sources, i.e. a high power diode laser (HPDL) and a fiber laser, on the structure and properties of the matrix in the form of titanium GRADE 1.

The test results show that the internal structure of the tested alloy, together with the obtained mechanical and functional properties, differs depending on the set of laser surface treatment parameters, including: laser beam power, the speed of its head advance, the amount of shielding gas and the amount of stopping powder. In all analyzed cases, a two-phase structure of titanium α + β with martensitic structure was identified. In the case of samples alloyed with Fe-N powder, the Ti(Fe,Ni) phase and eutectic in the form of a mixture of the secondary Ti_2(Fe,Ni) phase with the Ti-β phase were also identified.

It has been shown that during the crystallization of the liquid pool, uncontrolled precipitation of TiO/TiN phase particles occurs, which are responsible for the increase in the mechanical and functional properties of GRADE 1 titanium (precipitation hardening). Additionally, the tests of electrochemical corrosion in an aqueous 3.5% NaCl solution of the samples after alloying confirm clear changes in the behavior of the tested materials after alloying - the increase in corrosion resistance (compared to the result obtained for titanium GRADE 1) occurred in 14 out of 16 cases of the tested samples.