SARATOV FALL MEETING 2020
VIII SYMPOSIUM ON OPTICS & BIOPHOTONICS
OPTICAL TECHNOLOGIES IN BIOPHYSICS & MEDICINE XXII

Increasing the hardness of titanium by laser processing in a graphite environment

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Titanium alloys are widely used in aerospace and propulsion (turbine blades and blades), shipbuilding, and the petrochemical and electronics industries. Titanium has a tendency to fretting and low wear resistance. In order to improve the characteristics of the surface of titanium products, a modifying treatment is performed, which can be conditionally subdivided into three large groups: heat treatment, coating and chemical heat treatment. Titanium alloys are chemically active in a wide temperature range, which gives rise to the development of methods of chemical thermal treatment. The most technologically simple process is carburizing, which allows the formation of highly hard layers on titanium.

The aim of this work was to study the effect of the duration and energy of a laser pulse on the microhardness of the titanium surface after treatment in a powder graphite medium.

Laser treatment of a titanium sample was carried out in a graphite powder medium with a dispersion of 10-35 μm, with an overlap of 40-50%. The duration of a pulse (τ, ms) focused into a spot 0.7 mm in diameter was 0.5, 1, 1.5, 2, and 3 ms. The pulse energy (E, J) varied from 0.53 to 10.17 J (**fig. 1**).

The microhardness (H, GPa) was measured using a «PMT-3m» microhardness tester with an indenter load of 200 gf. Statistical processing of research results and construction of empirical models were carried out using the software package «DataFit9».

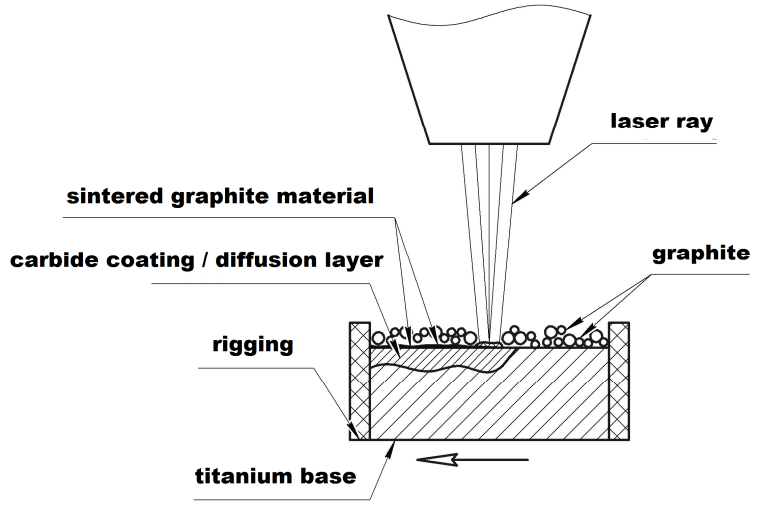

Fig. 1. Laser treatment of titanium in a graphite environment

The possibility of the formation of layers on titanium with a microhardness **$HV_{1.96}$ 2164 ± 268, which corresponds to 21.2 ± 2.6 GPa,** has been established.

The influence of laser processing conditions on the surface microhardness is described by the regression model:

H= 6.27+8.78×E-2.75×E^2+0.5×E^3-4.06×E^4+8.7×τ-16×τ^2+8.4×τ^3-1.4×τ^4, GPa (R2=0.84) (**fig. 2**).

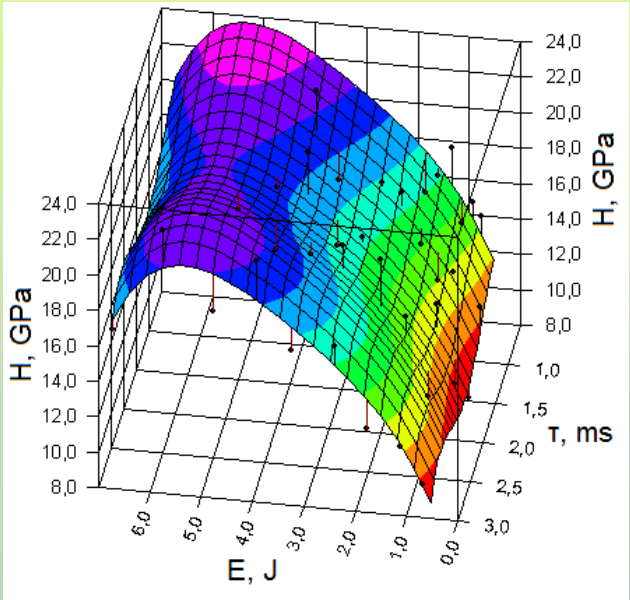

Fig. 2. Influence of energy (E, J) and laser pulse duration (τ, ms) on microhardness (H, GPa) of titanium surface