SURFACE MODIFICATION OF ADDITIVE MANUFACTURED METAL SPECIMENS BY AN INTENSE ELECTRON BEAM

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On the example of VT6 titanium alloy it is shown that successive surface modification of additive manufactured metal specimens in vacuum at an argon pressure of $3.5 \cdot 10^{-2}$ by ten pulses with 200 μs, 45 J/cm^2 and then by three pulses with 50 μm, 20 J/cm^2 provides a considerable decrease in their porosity and surface roughness (20 times for R_a) while their surface microhardness, friction coefficient, and wear level remain almost unchanged. After electron beam irradiation, the ultimate tensile strength of the material increases on 12%, and its tensile strain on 10% (fig. 1). For specimens obtained by conventional metallurgy and irradiated in the same modes, no such effects are observed.

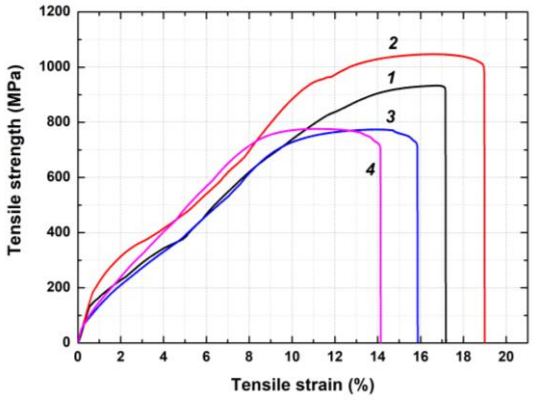

Figure 1. Strain hardening curves for VT6 titanium alloy under tension: *1* – additive manufacturing; *2* – additive manufacturing and irradiation; *3* – conventional metallurgy; *4* – conventional metallurgy and irradiation.

Our study shows that the difference in the mechanical properties of the materials is due to differences in their defect structure. After intense pulsed electron beam irradiation, the additive manufactured material reveals a polycrystalline structure with a grain size of 15–60 μm and a cellular structure with a cell size of 0.5–1.2 μm in the grain volume (fig. 2,a). The material obtained by conventional metallurgy assumes a polycrystalline structure with a grain size of 50–800 μm and a rough lamellar structure in the grain volume (fig. 2,b).

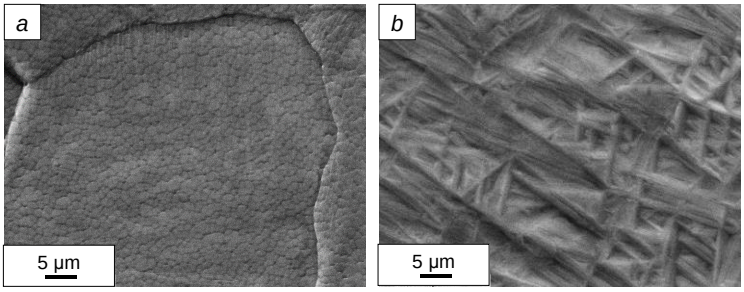

Figure 2. Intragrain structure of the surface layer of VT6 titanium alloy, formed as a result of irradiation with an intense pulsed electron beam of samples prepared a) by the method of additive technologies and b) methods of traditional metallurgy

The work was supported by the Russian Science Foundation (project No. 14-29-00091).