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PRODUCTION OF THE OBTAINING NANOSTRUCTURES PROCESS UNDER THE ACTION OF LASER RADIATION ON MATERIALS AND CUTTING TOOLS

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The results of calculations of temperature fields, temperature stresses, and temperature growth rates under the action of radiation sources with heat flux densities from 10^{11} to 10^{17} W/m² for operating times from 10^{-16} to 10^{-10} s on the VK VK4 are considered, the results of which are shown in Fig. 1. It can be seen that with an increase in the heat flux density, tem-

peratures increase at almost all studied depths – from 0 to $9,5 \cdot 10^{-7}$ m at an operating time of 10^{-10} s. Actions with shorter times retain almost the same character of the dependence of temperature on the heat flux density, the character is preserved, but the temperature values are significantly reduced. The obtained temperature distributions of the heat flux density show that for shorter times of the heat flux action, more successful temperature distributions are realized at higher heat flux densities (10^{15} – 10^{16} W/m²), whereas at 10^{-14} s this region of nanostructure production lies already at heat flux densities from 10^{13} to 10^{15} W/m², at large times of 10^{-12} s, this region moves towards lower heat flux densities and lies in the region from 10^{12} to 10^{14} W/m². For a time of 10^{-10} s, this region already lies in the range from 10^{12} to 10^{13} W/m². From these graphs, it is possible to assess the possibility of obtaining nanostructures at short times, i. e., at the femtosecond and picosecond ranges, but these graphs are insufficient to assess the possibility of obtaining nanostructures. It is also necessary to determine the rate of temperature rise from the heat flux density at the same times (from 10^{-16} to 10^{-10} s).

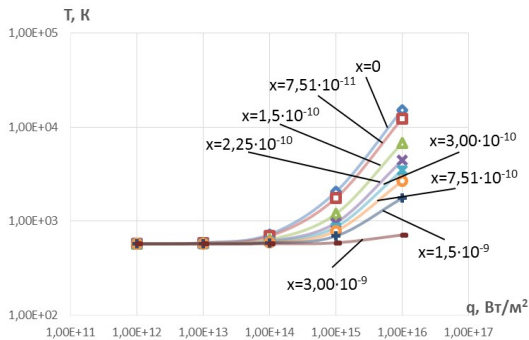


Fig. 1. The dependence of the maximum temperature in the area of the LI on VK4 from the heat flux density at different depths at the time of action: $t = 10^{-15}$ s

Analysis of the dependence of the rate of temperature change over time on the heat flux density at different depths and times of the heat flux from 10^{-16} to 10^{-10} s (Fig. 2). It can be seen that the rate of temperature change varies from 10^{13} to 10^{17} K/s, with a decrease in the action time, these speeds increase, and at a time of 10^{-12} s they already approach 10^{15} – 10^{18} K/s. A further decrease in time to 10^{-14} s, speeds approach 10^{17} – 10^{19} K/s, and at $t = 10^{-16}$ s, the rate of temperature increase approaches 10^{19} – 10^{20} K/s. It is seen that such high growth rates contribute to the formation of nanostructures and obviously can significantly accelerate this process. In Fig. 3 shows the dependences of temperatures at different depths in the area of the

LI on the VK VK4 TS on the heat flux density at the same action times (10^{-16} – 10^{-10} s). It can be seen that with increasing heat flux density, the values of temperature stresses increase significantly from 10^8 to 10^{13} Pa. These stresses in absolute value exceed the tensile strength, but since they act in a pulsed manner in a short time, fracture does not occur (deformation energy is insufficient). For small heat fluxes, temperature stresses accelerate the formation of nanostructures, and for large ones, starting from 10^{14} – 10^{16} W/m², they can independently form nanostructures due to deformation of the atomic lattice of the material.

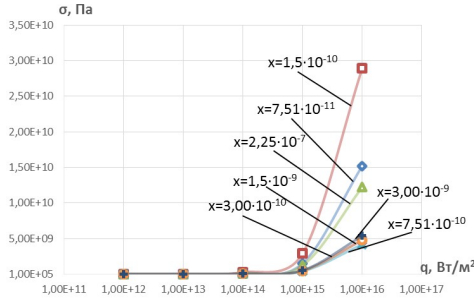


Fig. 2. The dependence of temperature stresses in the area of the LI on VK4 on the density of the heat flux at different depths at the time of action $t = 10^{-15}$ s

Similar studies were conducted for the beam radius $R = 10^{-6}$ m, the results of which are shown in Fig. 4. It can be seen that the nature of the curves in the dependences of the volume of nanograins on the minimum (Fig. 4, *a*) and maximum (Fig. 4, *b*) depths is preserved, but the grain volume increased by almost an order of magnitude.

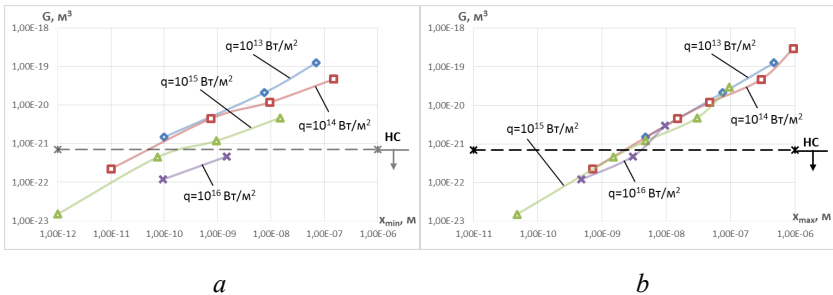


Fig. 3. Dependence of the nanocluster volume G on the minimum (*a*) and maximum depth (*b*) when exposed to laser radiation with different heat flux densities q laser radiation for TC VK8 with spot radius $R = 10^{-6}$ m

