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COMPARISON OF THE GRAIN SIZE UNDER THE FEMTOSECOND LASER ACTION ON FAST STEELS AND HARD ALLOYS

¹*Kostyk G.*, ²*Timofeev A.*

¹*National Aerospace University named after M.Ye. Zhukovsky
“Kharkiv Aviation Institute”*, ²*Kharkov Himprom Ltd, Ukraine*

At present, there have been experimental attempts to obtain nanostructures with the help of classical lasers, but in this case either a sub-microstructure grain or a microstructure grain was usually obtained. Due to the fact that there are lasers operating in the femtosecond time range, there are prospects for using these lasers to produce nanostructures, although even theoretical studies have not been carried out to evaluate the production of nanostructures.

All of the above indicates the relevance and timeliness of the study for engineering and, in particular, the production of cutting tools from hard alloys, which will significantly increase the efficiency (removable volume of material for the period of durability) and the operability of the tool.

The joint problem of thermal conductivity and thermoelasticity was carried out in the zone of laser radiation acting on the WK40 hard alloy, and the thermophysical and thermomechanical characteristics of the material were calculated using the quantum mechanical approach.

As a result of the calculations, the temperature and temperature stress fields, the temperature growth rate, and also the nanocluster volume, depending on the technological processing modes, were obtained. Taking into account the criteria of nanostructures, the volumes of zones where it is

possible to obtain nanostructures were calculated and their technological parameters of formation were recorded.

In Fig. 3 $10^4 - 3 \cdot 10^7$ show the dependence of the grain size on the heat flux density of $10^{10} - 10^{16}$ W/m² for operating times of 10^{-16} to 10^{-10} s and two sizes of the interaction spot of laser radiation with the material: $5 \cdot 10^{-7}$ m (b) and 10^{-6} m (a) for high-speed steels M35, Z80W9, M44 and Z80W18. It can be seen that for a spot size of $5 \cdot 10^{-7}$ m, the number of technological regimes under which nanostructures are realized is much larger than at 10^{-6} m. All this suggests that the laser beam focusing system needs to be improved to create nanostructures in a wider range of technological parameters. In the first case, 7 or more technological regimes are realized in which nanostructures are formed, and in the second, usually 1, 2, maximum 3 modes of nanostructure formation, and for P18, they are realized with a larger number of regimes.

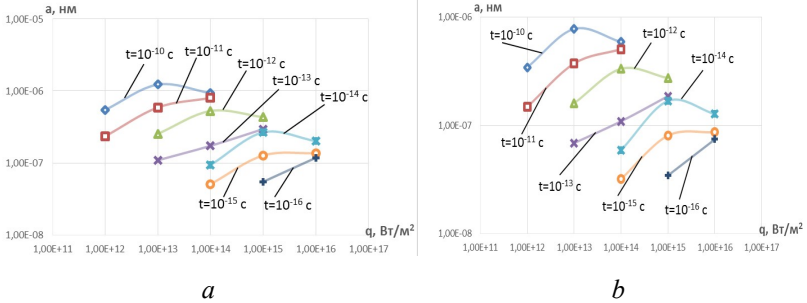


Fig. 1. The dependence of the grain size of the nanocluster on the density laser radiation heat flux q at different time t of its action in the zone where nanostructures are formed: a) $R = 10^{-6}$ m; b) $R = 5 \cdot 10^{-7}$ m (M35)

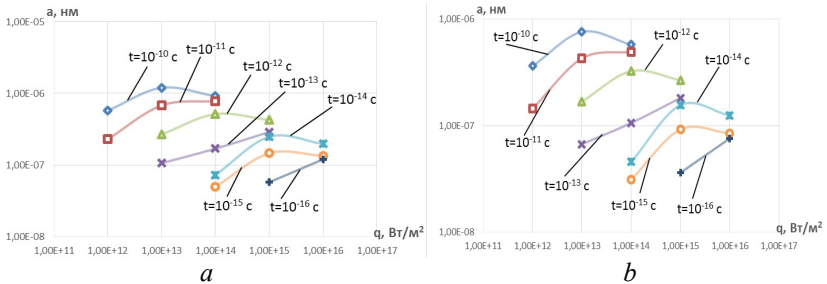


Fig. 2. The dependence of the grain size of the nanocluster on the density laser radiation heat flux q at different time t of its action in the zone where nanostructures are formed: a) $R = 10^{-6}$ m; b) $R = 5 \cdot 10^{-7}$ m (Z80W9)

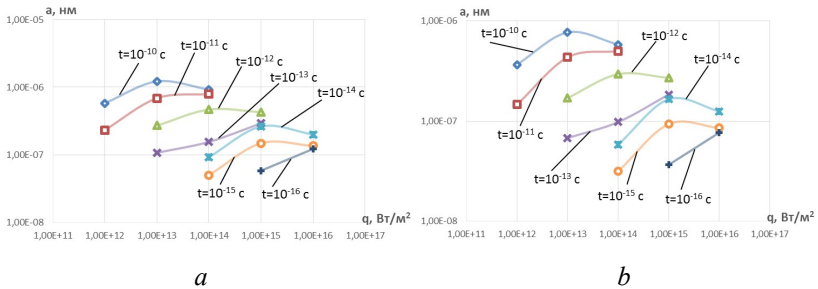


Fig. 3. The dependence of the grain size of the nanocluster on the density laser radiation heat flux q at different time t of its action in the zone where nanostructures are formed: a) $R = 10^{-6}$ m; b) $R = 5 \cdot 10^{-7}$ m (M44)

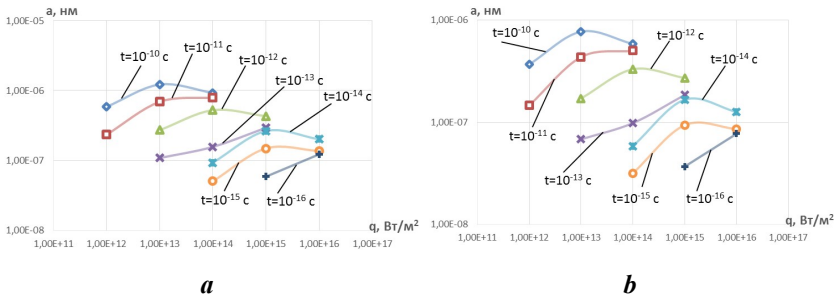


Fig. 4. Density dependence of the nanocluster grain size laser radiation heat flux q at different time t of its action in the zone where nanostructures a formed: a) $R = 10^{-6}$ m; b) $R = 5 \cdot 10^{-7}$ m (Z80W18)

It is shown that for M35, Z80W9, M44, Z80W18, MC301, MC318, MC306, MC111, MC137, the modes where nanostructures are realized, i.e. it is possible to choose technological parameters for obtaining NS, and with smaller spot sizes, the zone of such technological parameters is much larger.

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

Kostyuk G., Voliak E.

National Aerospace University named by N.Ye. Zhukovsky “KhAI”, Kharkiv

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-