высоких температурах (сульфиды) с высокой сопротивляемостью абразивному износу (фосфиды).

Показано, что при переходе от однокарбидного твёрдого сплава ВК6 к двухкарбидноу Т15К6, а в дальнейшим и к трёхкарбидному ТТ10К8Б приводит к росту размера зерна и максимальной глубине залегания нанокластера.

Так как рост размера зерна при нагревании твёрдосплавной пластины реализуется в процессе нанесения покрытия (и очистки), а также при нагревании пластины при резании необходимо учитывать в режимах очистки нанесение покрытия и в процессе резания этот эффект приводит к тому, что необходимо иметь запас по размеру зерна для учёта его роста.

INFLUENCE OF ORIGINAL GRAIN SIZE IN MATERIAL CUTTING TOOL ON THE EFFICIENCY OF THE FORMATION OF NANOSTRUCTURES UNDER THE FEMTOSECOND LASER RADIATION

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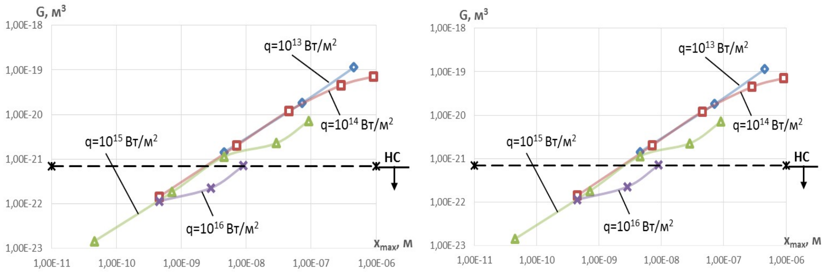
The dependences of maximum temperatures on the density of the heat flux generated by radiation ($q = 10^{12}...10^{16}$ W/m^2 and $t = 10^{-16}...10^{-17}$ s), which for MC306 are presented that at heat flux densities up to 10^{14} W/m^2, temperatures are insufficient to obtain nanostructures, but in this case only at times 10^{-13}–10^{-14} s there is a real possibility of the formation of nanostructures. An increase in the heat flux density to 10^{15} significantly expands the range of technological parameters that make it possible to obtain nanostructures, and they can already be implemented in the time range from 10^{-16} to 10^{-10} s, and, therefore, to ensure the production of nanostructures in the material, moreover, at shorter times they are realized closer to the surface, and at longer times – on the material of the cutting tool [1, 2].

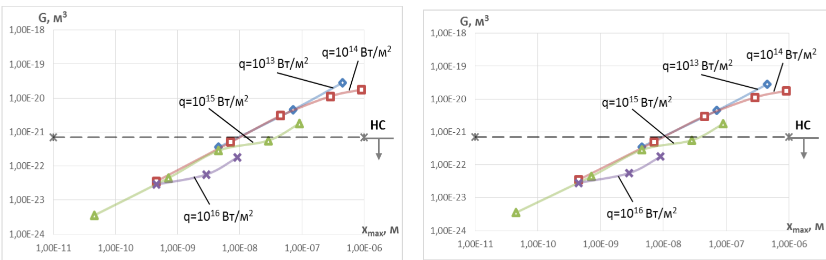
The results of similar studies are presented for CT from MC318 that the dependences retained their character, but the values of temperature stresses increased and even by significant values, which indicates a higher probability of destruction of the CT material, as well as a higher probability of the formation of nanostructures.

To assess the grain size and determine the probability of obtaining nanostructures, the grain volume was found and, taking into account the criteria for the formation of nanograins, the technological parameters of obtaining nanostructures were evaluated. So, in Fig. 1 shows the dependences of the nanocluster volume on the minimum and maximum depths of it under the action of laser radiation with different heat flux densities on the MC318 (Fig. 1, *a*) and MC306 (Fig. 1, *b*) carbides. It is seen that for MC306 there exists a large region of technological parameters where nanostructures are realized (see the areas under the dashed curve). These studies were carried out with a spot size of 10^{-6} m. The results of a similar study for the size of the contact spot of laser radiation with CT material of $5 \cdot 10^{-7}$ m are presented in Fig. 2. Comparing Fig. 1 and 2, it can be noted that with a smaller size of the contact spot of laser radiation and CT, there is a high probability of obtaining nanostructures in the studied range of technological parameters.



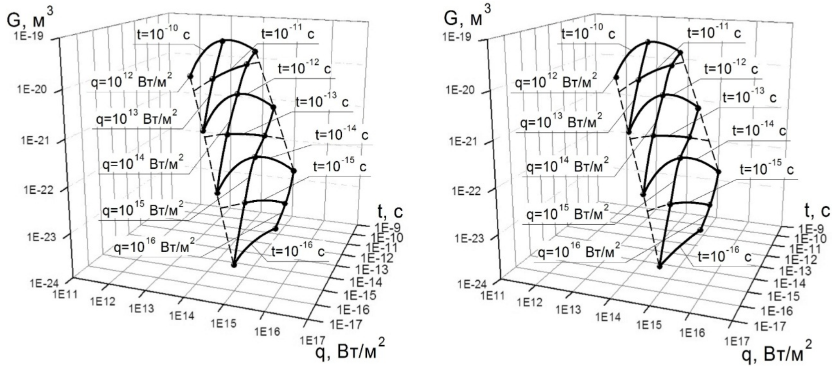
a *b*

Fig. 1. Dependence of the nanocluster volume ($R = 10^{-6}$ m) on the maximum depth of its occurrence under the action laser radiation with different heat flux densities *q* on carbides MC318 (*a*) and MC306 (*b*)



a *b*

Fig. 2. Dependence of the nanocluster volume ($R = 5 \cdot 10^{-7}$ m) on the maximum depth (*a*, *b*) under the action laser radiation with different heat flux densities *q* on carbides MC318 (*a*) and MC306 (*b*)



a *b*

Fig. 3. Dependence of the nanocluster volume on the heat flux density of laser radiation *q* and its action time t in the zone where nanostructures are formed at $R = 10^{-6}$ m (*a*) and $R = 5\cdot10^{-7}$ m (*b*) on carbides MC318 (*a*) and MC306 (*b*)

To expressly assess the feasibility of producing nanostructures with various technological parameters, spatial dependences of the nanograin volume on the heat flux density and its duration for MC318 at $R = 10^{-6}$ m (Fig. 3, *a*) and MC306 (Fig. 3, *b*). Comparing rice 3, *a* and 3, *b*, we see that with a smaller grain size, a large region of technological parameters provides nanostructures [3–5].

Comparing the range of technological parameters for producing nanostructures on radiation from MC318 and MC306, we can conclude that obtaining nanostructures on MC306 is more likely and, given the greater stability of the properties of this material, nanostructures will also have better physicomechanical characteristics.

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

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At present, there have been experimental attempts to obtain nanostructures with the help of classical lasers, but in this case either a submicrostructure 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