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STUDY OF OPTIMAL LASER PARAMETERS FOR OBTAINING NANOSTRUCTURES IN THE SURFACE LAYERS OF CARBON STEEL

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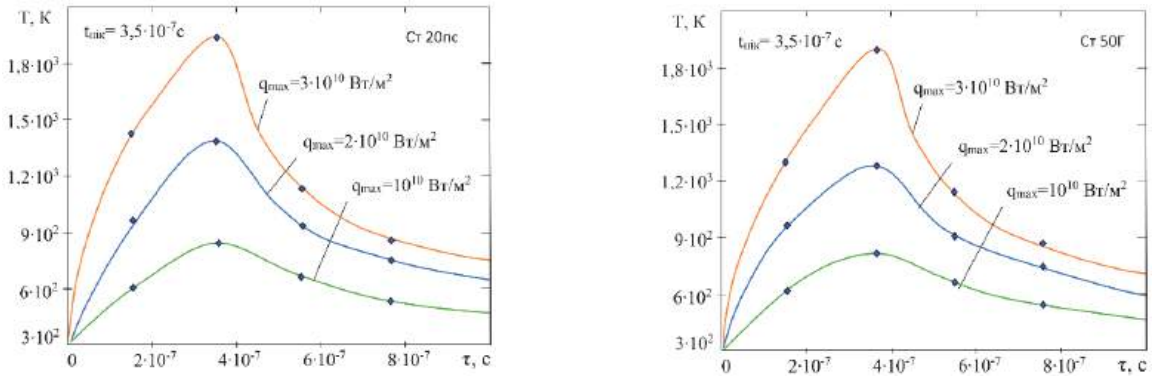
For the general verification of the model, the temperature fields in the zone of action of laser radiation on steel 20 (Fig. 1. a) and steel 50 (Fig. 1. b) were determined, and both the heating and cooling processes were considered. Calculations were performed for heat flow densities and time of its action, which are close to those required for obtaining nanostructures (500...2000 K), and at a rate of temperature increase exceeding 107 K/s. Yes, in fig. 1 shows the dependences of the maximum temperature in the spot $r = 0{,}1$ mm under the action of heat flows with peak densities q1max= 1010 W/m^2, q2max= 2·1010 W/m^2 and q3max= 3·1010 W/m^2 with an action time of 10^{-7} with steel 20 (Fig. 1, a) and steel 50 (Fig. 1, b).



a b

Fig. 1. Temperature distribution at a depth of 1 μm during the action of laser radiation on steel 20 – a and steel 50 – b. The peak density of the heat flux acting at the initial moment of time is 3.5·10^{-7} s

Also, in order to determine the optimal technological parameters of laser radiation when obtaining nanostructures, based on the calculations of temperatures and their growth rates, the dependences of the critical heat flow densities $q_{\text{кр}\,max}$ and $q_{\text{кр}\,min}$ on the time of their action, during which nanostructures are formed on 40X steel, were constructed.

The zone of technological parameters that ensures the production of nanostructures is limited by the lines $q_{\text{кр}\,max}$, $q_{\text{кр}\,min}$, the zone where the rate of temperature growth is insufficient and the zone where the probability of thermoelastic destruction is high. The paper shows the range of choice of which technological parameters of laser radiation, i.e. heat flux density and its action time, which ensure the production of nanostructures in the surface layer.