MATHEMATICAL MODELING OF HEATING OF HOMOGENEOUS METAL TARGETS BY A FOCUSED ELECTRON BEAM

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Some methods for local analysis of various objects in material science are based on the excitation of an informative signal by a beam of accelerated electrons (electron microscopy, spectroscopy of characteristic losses of electron energy, X-ray spectral microanalysis, etc.). However, as shown by us earlier for semiconducting targets, when the electrons of low (100 eV-8 keV) and medium (8-50 keV) energies decelerated in the target, only a small part of energy goes to the formation of informative signals and the most part of the energy goes to heating the sample [1, 2]. We have continued such works for other objects used in physical materials science and in this paper we have considered heating of homogeneous metal targets. As in [3], the problem of heat distribution in metal targets irradiated with sharply focused electron beams in the absence of heat exchange between the target and the external medium is considered by mathematical modeling methods. For a quantitative description of energy losses by beam electrons a model based on a separate description of the contributions of absorbed in the target and backscattered electrons and applicable to a wide class of solids and a range of primary electron energies is used [4, 5]. The heat transfer equation was solved using the Green's function, and problems related to the computational stability of the solution were discussed. Quantitative estimates of the temperature rise of various metallic targets under an electronic probe are carried out. Using the features of this approach, the nonmonotonic dependence of the temperature of the maximum heating in the target on the energy of the primary electrons is explained. The results are illustrated for some homogeneous metal targets.

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