THE DYNAMICS OF METALS AT PULSE INFLUENCE OF INTENSIVE STREAMS OF THE ELECTROMAGNETIC ENERGY[i]

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Interaction of intensive streams of the electromagnetic energy with metal is nonlinear and also depends on its microstructure, and on an influence duration τ_b. In a metal at $\tau_b \leq \tau_\varepsilon \sim 10^{-12}$ s, where τ_ε being the time of a balance establishment between electronic and ionic components, the non-equilibrium state is raised. At $\tau_\varepsilon >> \tau_b >> \tau_p \sim 10^{-14}$ s (τ_p being the time of a balance establishment in each of a component) this state represents the not isothermal plasma of solid-state density with electron temperature $T_e >> T_i$ (T_i being the temperature of a lattice (ions)).

For studying metal dynamics at $\tau_b >> \tau_p$ the one- and two-temperature models including thermodynamic functions and transport coefficients, fair both in the field of the condensed condition, and in the field of ideal plasma are proposed. The expressions for transport coefficients take into account also electron scattering on defects and grain boundaries. For research of dynamics of the metal irradiated with intensive electronic beams of subnano- and picosecond pulse duration, and also subpico- and femtosecond laser radiation, we propose the models according to which slow excitations are considered in hydrodynamic, and fast (collective) excitations - in kinetic approximation in view of the translation and wedge dislocations (the wedge dislocations always are present in the field of threefold joints of boundaries of the grains with size $d \leq 100$ nm).

The conditions of heating of a metal conductor by an electric current depending on its duration are analyzed. It was shown, that even in the idealized case of unstructured conductor its heating by a pulse electric current is non-uniform. It is established also, that in case of homogeneous liquid-metal conductor on section and length with a current, the magnetohydrodynamical convective instability developing in it resulted in formation of hydrodynamic and current vortex structures which was responsible, at least, for a conductor disintegration on particles in the size about diameter, and localization of electromagnetic energy.

Nanosized particle formation at an electric explosion of polycrystalline metal conductor with the grain size $d \leq 100$ nm was considered within the framework of mechanics of continuous media with microstructure. The conditions of conductor fracture were obtained as a result of the electromagnetic energy localization in area of intercrystalline boundaries. Expansion of the explosion products (drops and vapour) in buffer gas was considered within the framework of hydrodynamics of heterogeneous media (HHM) taking into account the coagulation of growing particles at collisions in a zone of intensive mixing of the explosion products with gas. Processes of drop origin from vapour, evaporations and condensation, a friction force dispersive and disperse phases, work of these forces, and also heat exchange between phases was alsos taken into account.

The computer simulation of dynamics of metal targets irradiated with the charged particle beams and their boundaries depending on irradiation duration was carried out, and also comparison with experiment was made. The simulation of dynamics of products of the electric explosion of a copper delay in the crystalline size $d \sim 68$ nm was also made in the assumption that conductor fracture took place as a result of the electromagnetic energy localization in area of the intercrystalline boundaries. The obtained distributions of particles in the size as a result of computer experiment were in qualitative and quantitative accord with experiment.

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