MODELING OF PHASE DYNAMICS AND KINETICS OF FRAGMENTATION AT SEVERE PLASTIC DEFORMATION

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Nodaway the metals are subjected to the different forms of processing for the achievement of the high mechanical properties (the high strength and plasticity). The most cardinally this purpose is reached by grinding of metals grain structure due to their processing by the methods of severe plastic deformation (SPD). Since such processing is very complex and the real experiments are enough expensive the development of the theoretical methods for their description acquires a large significance.

At present, a special theory is being developed. It is based on the Landau theory concept of phase transitions. It helps to describe quasi-brittle materials and grain grinding in the process of their processing by the SPD methods [1], the behavior of a thin lubricant layer. Within the framework of this theory, it is possible to explain many important features of the SPD process. It can describe the formation of the metal's "limiting" structure (the minimum average grain size) in particular. Moreover, the domains of the limiting structures formation have been investigated in terms of free energy [2]. However, the connection between generations of several types of defects has not revealed yet, for example, such defects as the grain boundary and dislocation. Their interaction can provide the stationary domains formation at the phase diagram.

The main purpose of our study is to describe the structural phase transition between two steady-states in terms of the internal energy (from the large grain state to the small one). After that to set the interaction effect of several types of defects on the limiting structure formation and to describe the kinetics of setting in the steady-state values. Moreover, to conduct an analysis of the external periodic influence on the considered model.

The density of grain boundaries, dislocations and entropy are introduced for describing the defect structures. This allows us to take into account the two channels of energy dissipation (thermal one and defects formation). The phase diagram that establishes the domains of the different limiting structures types realization is obtained. The formation conditions for two limiting structures are found. They correspond to the mode, in which there is a mixture of different grain sizes. The kinetics of setting in the steady-state values of the defects density is investigated within the scope of the adiabatic approximation, at which the dislocations density change follows the evolution of the grain boundaries density. It is demonstrated that grain sizes in the limiting structures decrease with an increase of the elastic strains. The analysis of external periodic influence shows that frequency and amplitude of external influence change the system behavior. The results are useful for investigation of metal fragmentation at low temperatures [3].

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