Effects of Imperfections on Instability Phenomena in Dissipative Solids

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The main objective of the paper is to study the onset of the instability for dissipative bodies with internal imperfections.

A simple model of an elastic-viscoplastic material with internal imperfections is proposed. This model is justified by physical mechanisms of polycrystalline matter flow in some regions of temperature and strain rate changes. The thermo-activated mechanism causes elastic-viscoplastic flow and the mechanism of void growth plus its diffusion field inserts evolution of imperfections in a material considered.

The voids (vacancies) within the grains are produced by plastic deformation and by irradiation damage.

To describe this model the modified material structure with internal state variable is used. A set of the internal state variables $\alpha(t) = (\underset{\sim}{E}_p(t), \varkappa(t), \xi(t))$ is introduced, where $\underset{\sim}{E}_p(t)$ is interpreted as the inelastic strain tensor, $\varkappa(t)$ as the isotropic work hardening parameter and $\xi(t)$ as the scalar measure of the concentration of voids. It is postulated that the evolution equation for ξ has the form of the diffusion equation.

As an example of application it is considered the straining process of cylindrical bar specimen under condition of uniform elevated temperature. The tensile velocity is assumed constant. The problem is treated as axisymmetric and quasi-static. Material of the specimen is assumed to be an elastic-viscoplastic with internal imperfections. Particular forms of the material functions involved in the theory are determined on the basis of available experimental data for mild steel.

Influence of diffusion effects caused by evolution of imperfections on the onset of the instability of straining process has been investigated. It has been found that the onset of the instability by necking mode is strongly dependent upon the diffusion cooperative effects.