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FAILURE MECHANISMS OF LIGHT ALLOYS WITH A BIMODAL GRAIN SIZE DISTRIBUTION

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Results of theoretical research of damage accumulation in ultrafine-grained (UFG) light alloys with grain size distribution under dynamic loading are presented. Physical mechanisms of dynamic fracture were investigated by numerical simulation method in titanium, magnesium, and aluminium alloys.
The multiscale level approach of computer simulation based on the discrete element method (DME) has been used for simulation of alloys structured representative volumes response to tension and compression at high strain rates.
2D and 3D models of representative volume element (RVE) were developed using experimental data on grains structure for plastic flow and damage nucleation simulation.
The model takes into account the influence of an average grains size, grain size distribution and concentration of precipitates on mechanical properties of alloys.
Fracture of fine-grained alloys under dynamic loading has probabilistic character and depends on parameters of structure heterogeneity. Formation of macro-scale failure zone is a result of several processes of structure evolution including a damage nucleation, a damage growth, and coalescence of damages. Damage nucleation is closely connected with strain localization at mesoscale level.
Results of computer simulation have been shown the high strain localization in UFG alloys under dynamic loadings depends on the ratio of volume concentrations of small and coarse grains.
Fine precipitates in alloys cause not only the hardening but also lead to change the influence of the grains size distribution on volume concentration of shear bands.
It was found that the effective yield stress and the dynamic strength of bulk ultrafine-grained aluminium and magnesium alloys with precipitation strengthening are higher in comparison to coarse-grained counterparts.
The ductility of UFG light alloys increases when a relative part of coarse grains in volume is decreased. Results of computer simulation can be used for an estimation of grains size distribution influence on the dynamic strength and ductility of UFG alloys processed by severe plastic deformation methods.