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Mechanical Behavior of Nanostructured and Ultrafine Grained Materials under Shock Wave Loadings. Experimental Data and Results of Computer Simulation.

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Features of mechanical behavior of nanostructured (NS) and ultrafine grained (UFG) metal and ceramic materials under quasistatic and shock wave loadings are discussed in this report. Multilevel models developed within the approach of computational mechanics of materials were used for simulation mechanical behavior of UFG and NS metals and ceramics. Comparisons of simulation results with experimental data are presented. Models of mechanical behavior of nanostructured metal alloys takes into account a several structural factors influencing on the mechanical behavior of materials (type of a crystal lattice, density of dislocations, a size of dislocation substructures, concentration and size of phase precipitation, and distribution of grains sizes). Results show the strain rate sensitivity of the yield stress of UFG and polycrystalline alloys is various in a range from 10^3 up to 10^6 1/s. But the difference of the Hugoniot elastic limits of a UFG and coarse-grained alloys may be not considerable. The spall strength, the yield stress of UFG and NS alloys are depend not only on grains size, but a number of factors such as a distribution of grains sizes, a concentration and sizes of voids and cracks, a concentration and sizes of phase precipitation.. Some titanium alloys with grain sizes from 300 to 500 nm have the quasi-static yield strength and the tensile strength twice higher than that of coarse grained counterparts. But the spall strength of the UFG titanium alloys is only 10 percents above than that of coarse grained alloys. At the same time it was found the spall strength of the bulk UFG aluminium and magnesium alloys with precipitation strengthening is essentially higher in comparison of coarse-grained counterparts. The considerable decreasing of the strain before failure of UFG alloys was predicted at high strain rates. The Hugoniot elastic limits of oxide nanoceramics depend not only on the porosity, but also on sizes and volume distribution of voids.