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RADIATION PROPERTIES OF THE METAL STRUCTURAL MATERIALS DURING LOW-TEMPERATURE DAMAGING IRRADIATION

V.M. CHERNOV

Summary

Physical-mechanical properties of structural materials (SM) with the body-centered cubic (BCC - ferritic-martensitic steels, vanadium alloys, etc.) and face-centered cubic (FCC - austenitic steels, etc.) crystal lattices in conditions of "before-after-during" low-temperature damaging irradiation were reviewed and analyzed. Substantial qualitative and quantitative distinctions of states and properties of SM "before" (equilibrium state), "after" (equilibrium state with the additional radiation strengthening) and "during" (non-equilibrium state) irradiation occur.

Physical multilevel dislocation model of the formation of the states of the low temperature embrittlement (the formation of the temperature of the ductile-brittle transition) and brittle fracture (the cold brittleness) of SM are suggested. The conditions of the formation of the temperature of the ductile-brittle transition анв the brittle fracture of SM by rupture or shear are determined. The speeds of a propagation of the critical rupture and shear cracks are determined by the dynamic mobility of dislocations on the fronts of the cracks.

The conditions for the occurrence of the cold brittleness with the brittle fracture in BCC SM "before-after" irradiation can be implemented (the cold brittleness is the typical phenomenon), and in FCC SM are not implemented (the cold brittleness is absent).

The formation of the cold brittleness will occur in the BCC SM "after" irradiation by the same mechanisms as "before" irradiation but with account of the additional radiation hardening of the BCC SM as the cause and effect of the radiation increase of the temperature of the ductile-brittle transition (low temperature radiation embrittlement).

The non-destructive acoustic method for the determination of the temperature of the ductile-brittle transition is suggested. The corresponding temperatures of the ductile-brittle transitions measured by the acoustic and the destructive shock methods are in a good mutual correlation.

"During" the low-temperature damaging irradiation in BCC SM, the state of the low-temperature radiation embrittlement with a brittle failure by rupture (mainly dangerous cold brittleness) is not formed (the cold brittleness by rupture is absent), but the state of the low-temperature radiation embrittlement with a brittle failure by shear may arise.