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Radiation Properties of the Metal Structural Materials during Low-Temperature Damaging Irradiation

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The structure and physical-mechanical properties of the metal structural materials (SM) with BCC (ferrite-martensitic steels, alloys of vanadium, etc.) and FCC (austenitic steels, etc.) crystal lattices in the conditions of "before-after-during"low-temperature irradiation were analyzed. The qualitative and quantitative distinctions of the states and properties of SM "before-after"(an equilibrium state) and "during"(essentially non-equilibrium state) irradiation occur. Depending on the rigidity of the stress-deformed state, type of a crystal lattice, the low-temperature yield strength and mobility of dislocations there can be different modes of the plastic deformations with the brittle fracture by rupture or shear (cold brittleness).The conditions for occurrence of the cold brittleness are the formation of the critical cracks of rupture and shear, generating dislocations, high low-temperature yield strength, high starting stress for movement of dislocations and low level of viscous braking of the dislocations in the dynamic area of their mobility on the fronts of a cracks of rupture and shear. The speeds of propagation of a critical crack and deformation shear strip are determined by the dynamic mobility of the dislocations on their fronts. The conditions for occurrence of the cold brittleness can be implemented in BCC SM, defining their temperature ranges of the cold brittleness, and are not implemented in FCC SM (the cold brittleness is absent).

"Before-after"irradiation in BCC SM the cold brittleness manifests itself by the modes of the plastic deformation with a brittle fracture during an avalanche propagation of a critical crack (rupture cold brittleness) or with a brittle shear during formation and avalanche propagation of the deformation shear strips (shear cold brittleness). "During"low-temperature irradiation in BCC SM the state of irradiation cold brittleness with a brittle fracture by rupture or shear is not formed (absent).

Possibilities and difficulties are discussed for development of the physical models and computer simulation of the radiation structures, defects and physical-mechanical properties of SM.

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