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Plastic instability behavior of bcc and hcp metals after low temperature neutron irradiation

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Abstract

Plastic instability behavior in tension was investigated for four body centered cubic or hexagonal close packed pure metals, V, Nb, Zr, and Mo after low temperature (~80°C) neutron irradiation from 0.0001 dpa to 0.7 dpa. In the relatively ductile V, Nb, and Zr, the yield stresses were almost doubled by irradiation up to 0.7 dpa. At doses higher than 0.001 - 0.01 dpa those three metals showed prompt necking at around the yield point, with significant amount of necking strain. High purity Mo was fully embrittled from the lowest dose of 0.0001 dpa; uniform elongation was less than 0.1% and tensile failure occurred in an intergranular fracture mode without necking ductility. V showed a quasi-brittle failure after irradiation to a dose of 0.69 dpa. For the metals except Mo, it was found that prompt necking occurred when the yield stress exceeded the plastic instability stress of the unirradiated material. The plastic instability stress was almost independent of neutron dose. Transmission Electron Microscopy (TEM) revealed that the samples which showed prompt necking at yield deformed by dislocation channeling. The relationship between the reduced work hardening after irradiation and the deformation mechanism is discussed.

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