IRRADIATION INDUCED HARDENING OF ADVANCED BCC-STRUCTURED ALLOYS

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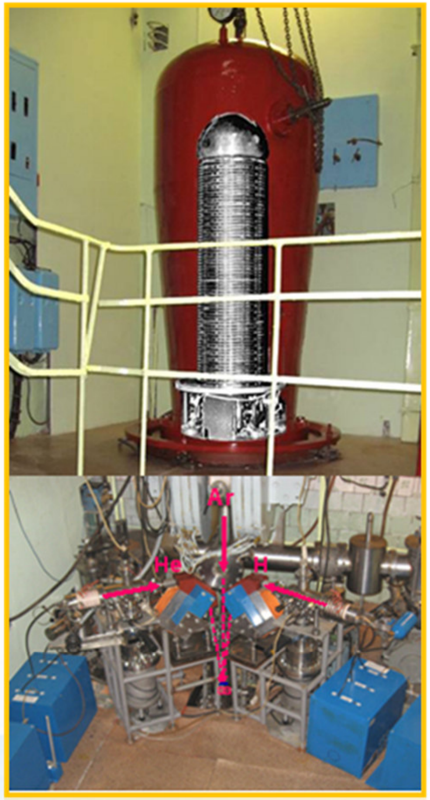
MATERIALS AND METHODS

- The new lightweight Ti-based multi-principal element alloy 61Ti-10Cr-7Al-11V-11Nb (at. %) with high ductility at room and elevated temperatures (Ti-MPEA)
- T91 ferritic-martensitic steel (T91)
- T91 modified with severe plastic deformation (T91-MSPD)

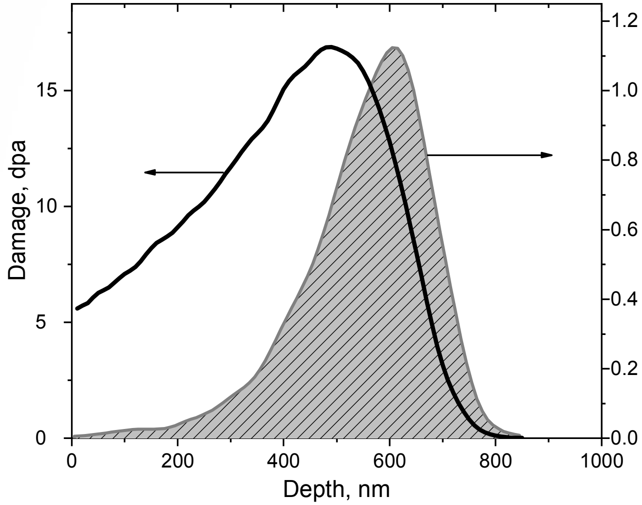
Irradiation

1.4 MeV Ar ions at Troom

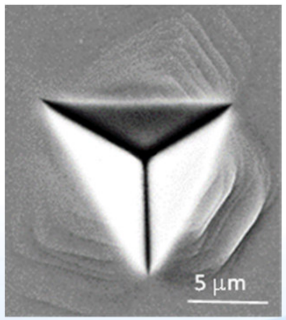
Dose range 1 - 10 dpa



The accelerating-measuring system ‘ESU-2’



Calculated depth distribution profiles of damage and concentration of 1.4 MeV Ar^{+} ions



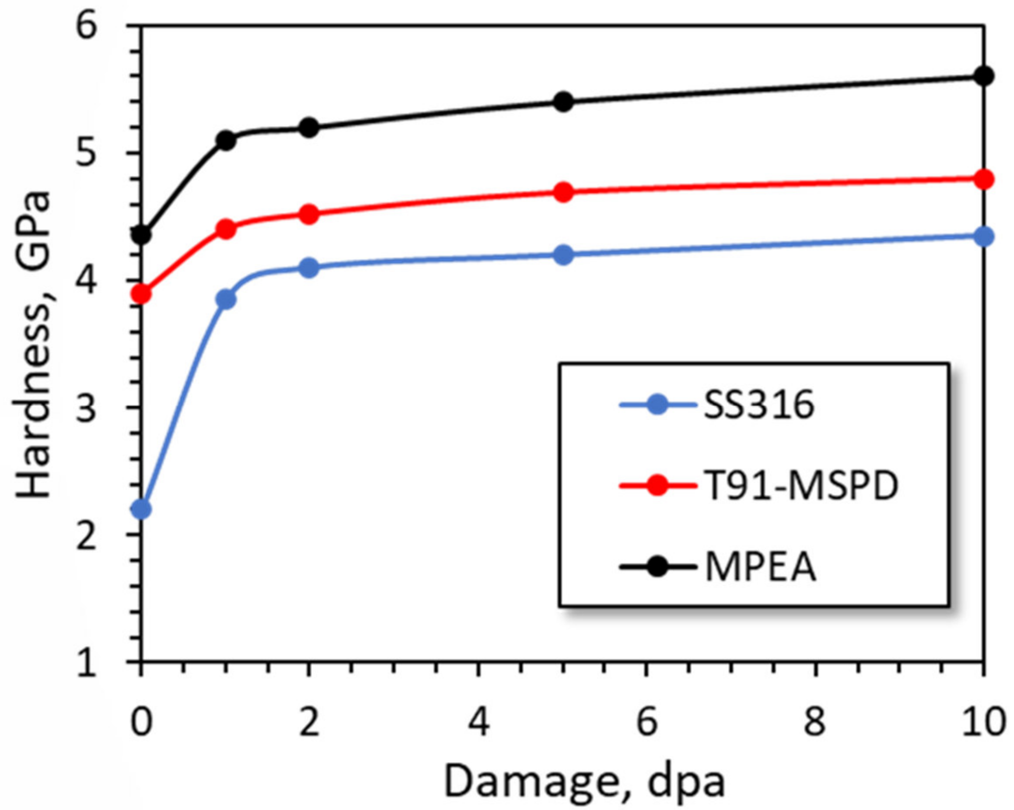
Indent

Nanoindentation

Nanohardness was measured by Nanoindenter G200 with a Berkovich type indentation tip.

THE DOSE DEPENDENCE of ION IRRADIATED MATERIALS HARDNESS

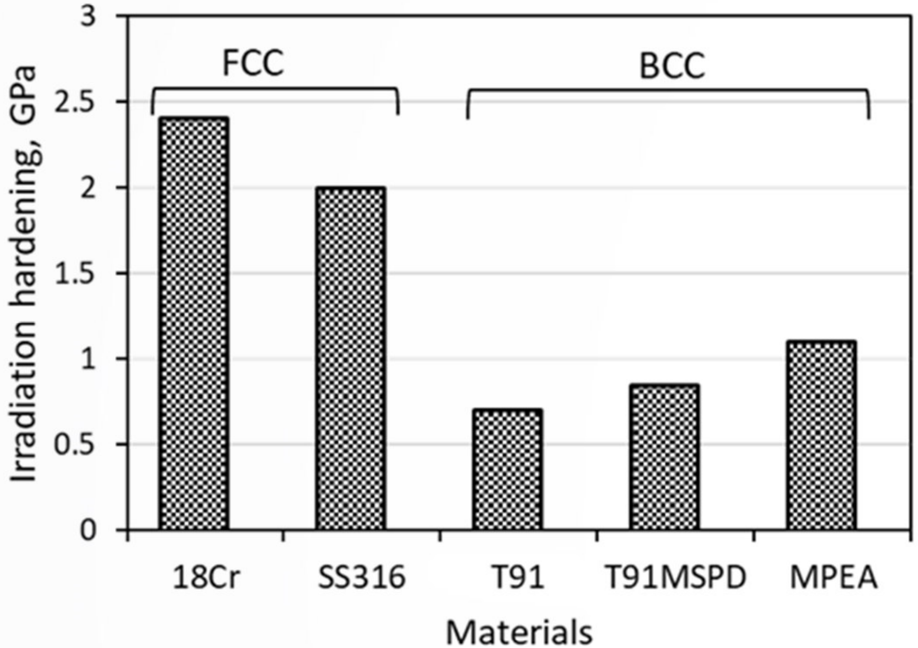
Alloys with BCC phase structure, including Ti-MPEA, T91 and T91-MSPD steels have been investigated in relation to the hardening/embrittlement phenomenon under irradiation. Comparison of the obtained data with data for conventional austenitic stainless steels 18Cr10NiTi (18Cr) and SS316 after irradiation under identical conditions was carried out.



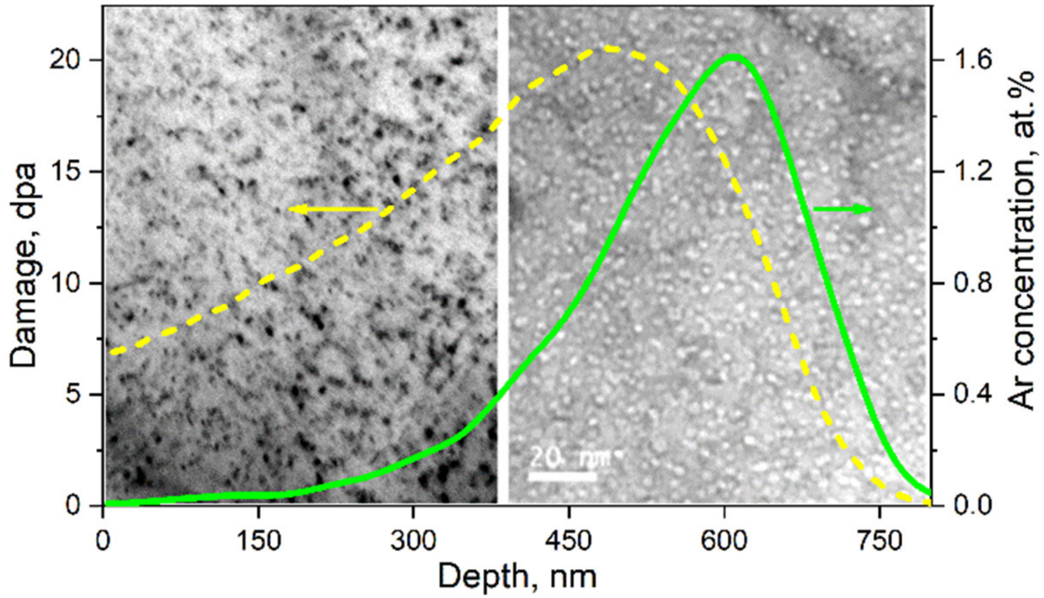
Radiation strengthening is dose-dependent, with saturation typically occurring at doses exceeding a critical value. The most prominent impact of irradiation occurs at a dose of around 1 dpa, transitioning to a quasi-saturation mode at higher fluences.

COMPARISON OF RADIATION HARDENING OF BCC AND FCC ALLOYS

The radiation hardening was determined as $\Delta H = H_0^{irr} - H_0^{unirr}$. Hardness values H_0^{irr} for irradiated materials were taken at dose of 10 dpa.



The radiation hardening for the studied materials irradiated under identical conditions



TEM micrographs of radiation-induced dislocations and Ar-filled nanocavities

✓ Radiation-induced hardening caused by the formation of dislocation loops and radiation-induced cavities.

✓ The radiation tolerance of BCC metals is superior to that of FCC metals.

✓ Contributing factors may include reduced in-cascade production of sessile point defect clusters, lower dislocation bias, and higher self-diffusion coefficients. The latter is particularly important because the higher self-diffusion coefficients in BCC metals at equivalent homologous temperatures enhance self-recovery diffusion mechanisms and suppress radiation damage accumulation.

Дякую за увагу!