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Integrated Nanoindentation and Modelling Approaches to Determine Ion Induced Hardening Behaviour in AA6061 and MA957

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Materials used in nuclear applications are exposed to radiation which causes changes to their properties, most significantly with regard to the hardness and microstructure. The present work investigates the changes in hardness resulting from heavy ion irradiation damage in aluminium alloy AA6061-T6 after irradiation with 12 MeV Au ions and contrasts it with the changes in the hardness of ferritic alloy MA957 irradiated using He ions at various energies. The mechanical test data was obtained using the oblique cross section (OCS) nanoindentation method for AA6061-T6 while the top down method was used for MA957 allowing for good depth resolution and sharper peaks.

A multiscale assessment framework was proposed through combinatorial modelling approaches including the Monte Carlo (SRIM) simulation of ion irradiation and continuum finite element modelling to account for damage saturation. The simulation results were compared and validated against the experimental data to elucidate the hardening effect resulting from ion irradiation and the resultant changes in the hardness profile. The work was able to determine the stress distribution beneath the indenter while revealing the stratified nature of damage in ion beam irradiation along with the occurrence of complex plastic deformation in the irradiated zones.

Data from literature on neutron irradiation studies with regard to hardening rates, dpa dependence and flow stress for bulk polycrystalline specimens was used to analyse the stratified layers produced from ion irradiation at the micromechanical scale in the FE model. This methodology was used to predict the hardening response of ion irradiated materials that are thermodynamically stable and show hardening rates independent of irradiation dose.

Speakers Gender

Male

Travel Funding

No

Level of Expertise

Student

Do yo wish to take part in the poster slam

Yes

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