

References

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5 - 31 The Thermal Stabilization Effect of Inert Gas Atoms on the Irradiation Hardening in V alloy

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Vanadium (V) alloy is an attractive candidate materials for the tritium breeding modules (TBM) of blankets in fusion reactors. In this study, V-5Cr-5Ti alloy was irradiated by 122 MeV Ne ions (0.1 and 0.3 dpa) and 352

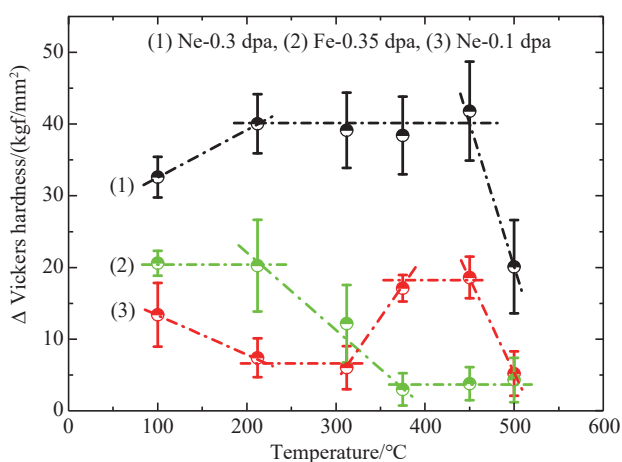


Fig. 1 (color online) The dependence of radiation hardening on annealing temperature for the samples irradiated with Ne and Fe ions.

MeV Fe ions (0.06, 0.20 and 0.35 dpa), and subsequently was annealed in the temperature from 212 to 500 °C. The hardening behavior and its thermal stability due to the existence of inert gas atoms were investigated. The Vickers hardness results (as shown in Fig. 1) indicate that more significant hardening was observed under Ne ion irradiation at damage levels higher than 0.05 dpa compared to Fe ion irradiation. During the annealing process, the hardening produced by Fe ion irradiation started to recover at a temperature higher than 212 °C and was eliminated at a temperature higher than 375 °C. For the sample irradiated with Ne ions, the irradiation hardening of the sample with 0.3 dpa can sustain at a temperature up to 450 °C, but an evident reduction of hardening in the sample with 0.1 dpa was observed after annealing at 212 °C. This suggested that the existence of inert gas atoms had a thermal stabilization effect on radiation hardening, but it required a critical concentration of Ne atoms.

After annealing at 500 °C, TEM results showed that bubbles with a more homogenous distribution were observed in the sample with 0.1 dpa produced by Ne ion irradiation, but the corresponding hardness increment has been significantly reduced and is comparable to the hardness of the sample with 0.35 dpa produced by Fe ions followed by annealing at 500 °C. This revealed that these small bubbles (~1.2 nm, as shown in Fig. 2) with high density have a weak contribution to the radiation hardening, and the major contribution to radiation hardening is still from dislocation loops.

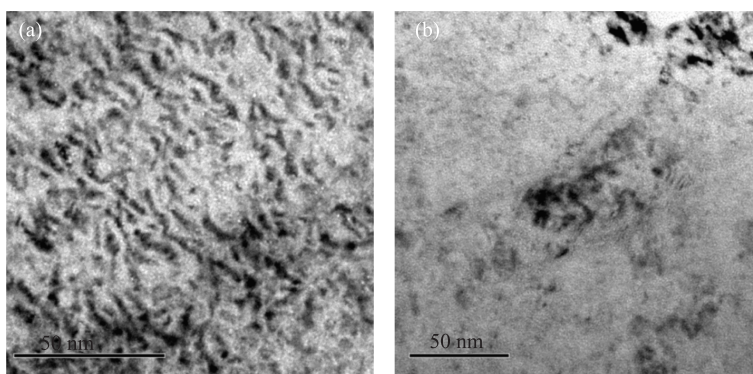


Fig. 2 (color online) TEM results of (a) the sample with 0.1 dpa produced by Ne ion irradiation and (b) sample annealed at 500 °C for 1 h under vacuum condition.

During the annealing process, an evident increase of hardness for the sample with 0.1 dpa was observed after annealing at 375 °C, which can sustain at a temperature up to 450 °C. However, the radiation hardening of the

sample with 0.3 dpa almost sustained unchanged at a temperature up to 450 °C. After annealing at 500 °C, a drastic reduction of hardness was observed for the samples irradiated by Ne ions to 0.1 and 0.3 dpa. The different annealing behaviors of radiation hardening at different doses under Ne ion irradiation were possibly from the evolution of bubbles growth and the interaction between interstitial clusters and Ne atoms.

5 - 32 Optical Emission from SiO₂ Irradiated by Xe^{q+} Ions*

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Swift heavy ion irradiation of solid materials is a complicated physical process that involved a large number of particle emission processes, including ultraviolet visible light emission. In order to study the ultraviolet visible light emission induced by fast heavy ions on solid, a measurement platform for swift heavy ion irradiation

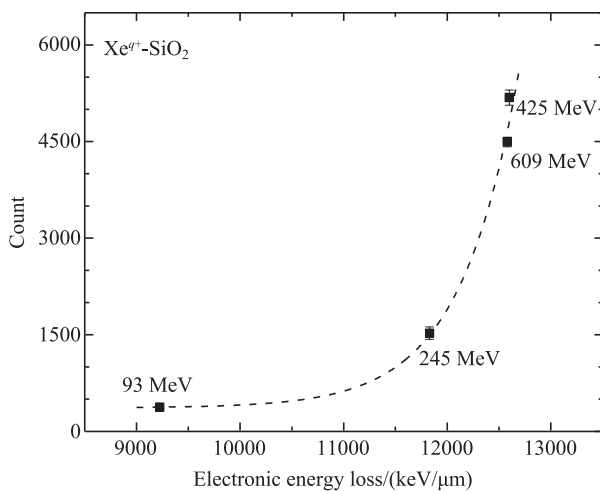


Fig. 1 (color online) The intensity of emission bands of centered at 461 nm from SiO₂ irradiated by 93~609 MeV Xe^{q+} ions as a function of electronic energy loss.

was built in the medium energy irradiation terminal SFC-T1 of Lanzhou Heavy Ion Accelerator. Swift heavy ion irradiation can modify the crystal structure and optical property of optical material SiO₂^[1,2]. The irradiation experiment was performed with Xe^{q+} ions. During irradiation, the emission spectra, in a range of 200~800 nm, from SiO₂ irradiated by 93~609 MeV Xe^{q+} ions, were obtained. Two emission bands centered at 461 and 631 nm were observed^[3]. These emission bands are produced by Frenkel exciton radiation recombination. Figure 1 shows that the light intensity increases with increase of the electron energy loss^[3]. Ion range and recoil atom distribution, target ionization (energy loss to target electrons), damage production in SiO₂ were simulated by the SRIM code. It indicates that electron energy loss plays a leading role in the process of optical emission. In-situ measurement of the optical emission is of great significance in studying the radiation modification and can help to understand the process of crystal damage caused by ion irradiation.

References

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* Foundation items: National Natural Science Foundation of China (12104463, U1532262)