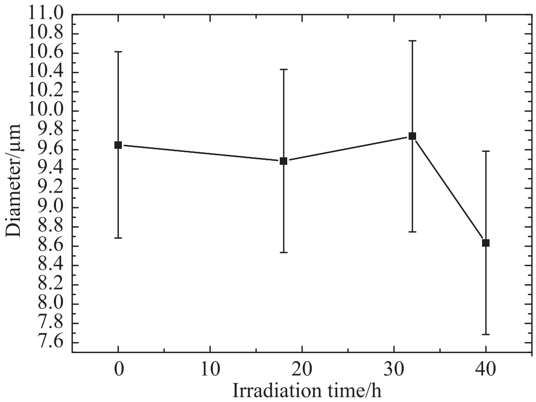

Fig. 1 The diameter of SiC fiber as a function of the irradiation times (electron fluence) after SiC fibers were irradiated by electron beams with different times.

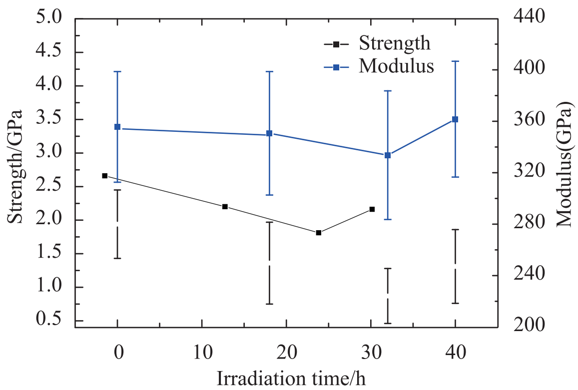

Fig. 2 (color online) The tensile strength and elastic modulus of SiC fiber as functions of the irradiation times (electron fluence) after SiC fibers were irradiated by electron beams with different times.

* Foundation item: National Natural Science Foundation of China (11675231, 91426304, 11105191) and National Magnetic confinement Fusion Progiam (2011GB108003).

4 - 33 Irradiation Hardening of V-4Cr-4Ti and V-5Cr-5Ti alloys Due to Helium Implantation and Displacement Damage

Yan Tingxing[1,2], Zhang Chonghong[1], Yang Yitao[1], Zhang Liqing[1] and Ma Tongda[3]

([1]Institute of Modern Physics, Chinese Academy of Sciences, Lanzhou 730000, China;
[2]University of Chinese Academy of Sciences, Beijing 100049, China;
[3]General Institute for Nonferrous Metals, Beijing 100088, China)

Vanadium alloys (V-Cr-Ti series) are important candidate materials for blanket components of fusion reactors due to their low activation and high strength at elevated temperatures. Low-temperature irradiation embrittlement determines the operation temperature limit of Vanadium alloys for the application to structural materials of fusion reactors irradiation response of vanadium alloys needs to be clarified for their application.

In the present study, specimens of two alloys (V-4Cr-4Ti and V-5Cr-5Ti) were irradiated with energetic He ions and heavy ions to understand hardening of the alloys due to helium accumulation and cascade damage production. A layer of a uniform helium concentration and displacement damage in the specimens were produced by varying energy of He ions and heavy ions (Ni, Sn), as shown in Fig. 1. Irradiation hardening was tested by using the nanoindentation technique. The results show that the Soft Substrate Effect(SSE) can be effectively avoided in the specimens irradiated with heavy ions (Ni and Sn) with kinetic energies of a few MeV/u. The nano-hardness gradient due to the Indentation Size Effect(ISE) was analyzed by the Nix-Gao model, as shown in Fig. 2. Values of nano-hardness corresponding to the infinite depth were obtained. Fig. 3 shows dose dependence of bulk-equivalent

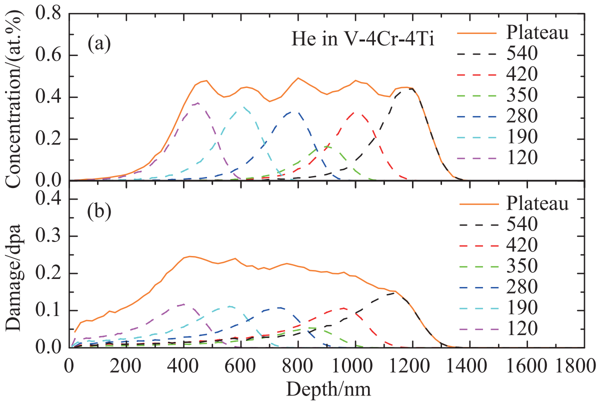

Fig. 1 (color online) The distribution of He ion concentration (a) and DPA (b) in V-4Cr-4Ti obtained from SRIM2013 simulation.

hardness for V–4Cr–4Ti alloy and V–5Cr–5Ti alloy with He/Sn ion irradiation. The nano-hardness increases with increasing displacement damage at low doses and tends to saturation at 4 200 appm/0.2 dpa under He ion irradiation. Hardening by heavy ion irradiation to the same displacement damage was lower compared with He ion irradiation. The V-5Cr-5Ti alloy shows less hardening under the same irradiation condition compared with the V-4Cr-4Ti alloy. The defects production under different irradiation conditions was analyzed by using rate equation approach. The numerical calculation shows a more significant growth of dislocation loops under helium ion irradiation, which contributes to irradiation hardening.

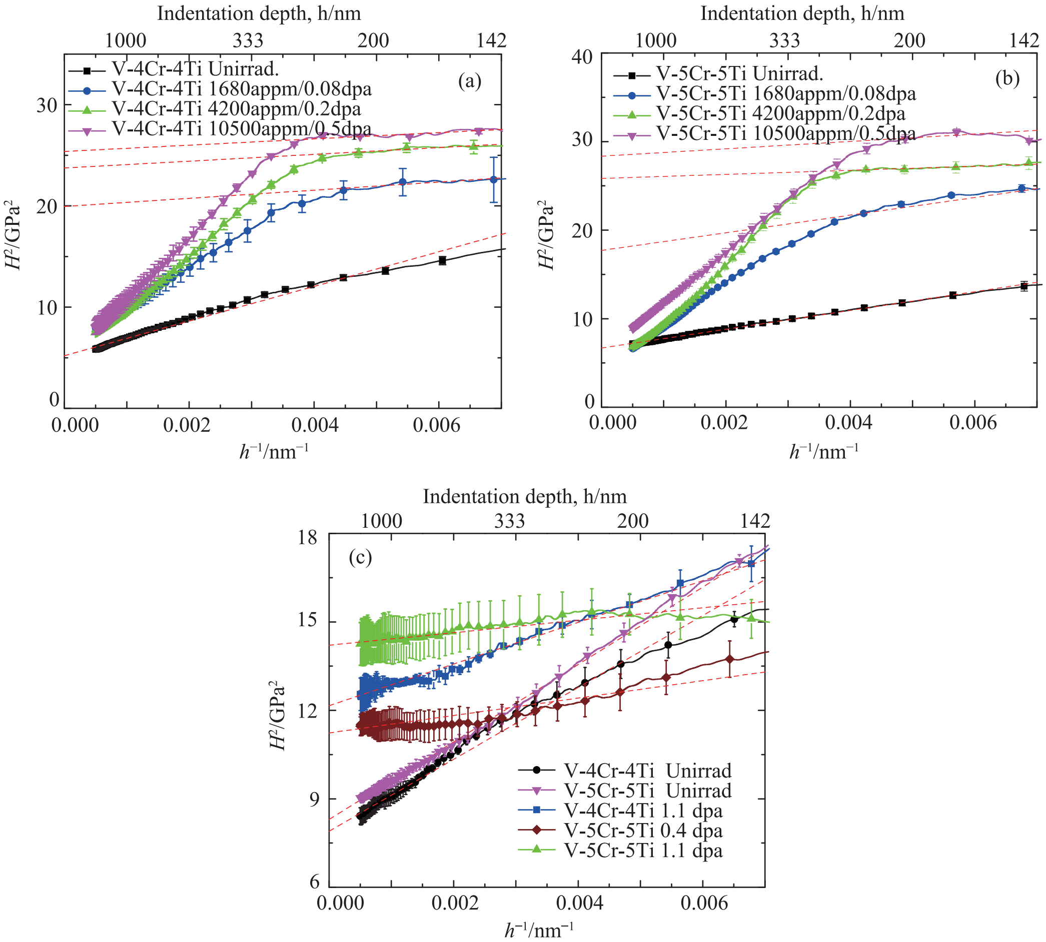

Fig. 2 (color online) Plots of H^2 vs. h^{-1} for V-4Cr-4Ti (a) and V-5Cr-5Ti (b) alloy with and without He ion irradiation, and V-4Cr-4Ti and V-5Cr-5Ti with and without Sn ion irradiation (c).

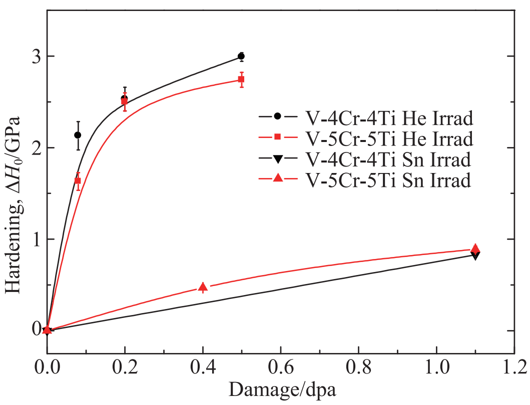

Fig. 3 (color online) Plots of ΔH_0 vs. damage for V-4Cr-4Ti and V-5Cr-5Ti alloy with He/Sn ion irradiation.