(1) The tendencies and peaks of ΔS parameter plots are consistent with those of dpa according to SRIM calculation for all samples.

(2) The ΔS values for both the sample 1# and 2# only implanted by H ions with higher peak concentration and lower dpa are larger than sample 4# only implanted with He ions.

(3) With increase of H ion irradiation dose, the ΔS values of the He+H samples increase as well as those of the H samples.

(4) The ΔS values of the He+H samples are larger than thode of the He samples but smaller than those of the H samples.

The profiles of vacancy-type defects in the SIMP steels implanted with H , He and He+H (pre-implanted He followed by H) respectively were characterized by positron annihilation Doppler broadening spectroscopy. It is found that the increase of S parameter induced by H-implantation is more remarkable than that induced by He-implantation. Another interesting finding is that the S values of He+H sample were smaller than those of H sample, This indicated that the information of H-V complexes were suppressed by pre-implanted He.

References

[1] K. Yang, W. Yan, Z. G. Wang, et al., Jinshu Xuebao/Acta Metallurgica Sinica, 52(10)(2016)1207.
[2] Y. E. Kupriiyanova, V. V. Bryk, O. V. Borodin, et al., Journal of Nuclear Materials, 468(2016)264.
[3] P. Vladimirov, A. Möslang., Journal of Nuclear Materials, 329–333(1–3 PART A)(2004)233.
[4] J. Marian, T. Hoang, M. Fluss, et al., Journal of Nuclear Materials, 462(2015)409.
[5] G. D. Tolstolutskaya, V. V. Ruzhytskiy, I. E. Kopanets, et al., Journal of Nuclear Materials, 356(1–3)136.
[6] T. Tanaka, K. Oka, S. Ohnuki, S. Yamashita, Journal of Nuclear Materials, 329–333(1–3 PART A), (2004) 294.
[7] E. H. Lee, J. D. Hunn, G. R. Rao, et al., Journal of Nuclear Materials, 271–272(3791)(1999)385.
[8] Z. Shen, Z. Zheng, F. Luo, et al., Fusion Engineering and Design, 115(2017)80.
[9] E. Wakai, T. Sawai, K. Furuya, et al., Journal of Nuclear Materials, 311(2002)278.
[10] A. Hasegawa, S. Miwa, S. Nogami, et al., Journal of Nuclear Materials, 329–333(1–3 PART A)(2004)582.

4 - 8 Study on the Radiation Effect of SiC Fiber

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SiC fibers can significantly improve the properties of SiC_f/SiC_m ceramic matrix composites which are considered as advanced materials for nuclear system. These materials exhibit interesting features such as a low activation level and a higher operating temperature in comparison to ferritic steels and vanadium alloys[1]. Such properties make them promising candidates for use as fuel cladding, structural components or flow channel inserts. However, their performances strongly depend on their complex microstructure which undergoes significant changes when they are irradiated. It is necessary to study the performance of SiC fiber under irradiation.

The experimental object is the KD-II SiC fiber, which is independently developed and produced by National University of Defense Technology. Table 1 shows the basic properties of silicon carbide fiber[2]. Figure 1 shows SAED pattern from the unirradiated fibers. The circular ring pattern is indicative of nanostructured material, and indexing of the rings reveals a consistent 3C SiC polytype. The SRIM 2010 code was used to assess the damage induced in the material. The displacement threshold energies for C and Si sublattices were, equal to 20 and 35 eV[3], respectively. Calculations show that 246.8 MeV Ar^{12+} ions have a projected range of about 52.8 μm in SiC fiber which is greater than the fiber diameter.

Table 1 The properties of the KD-II SiC fiber.

Properties	KD-II
Fiber diameter/μm	11
Tensile strength/GPa	3.0
Young's modulid/GPa	300
Elongation/%	1.5
Density/(g/cm^3)	2.76

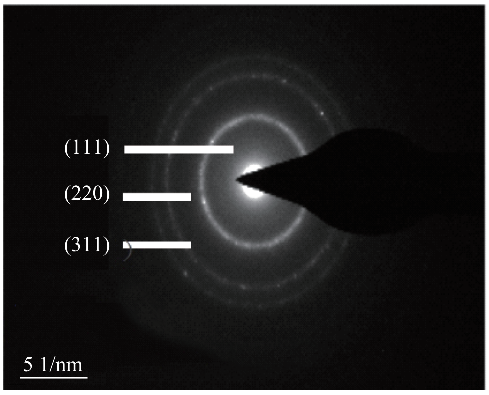

Fig. 1 Diffraction pattern from the unirradiated fiber.

Phases in the SiC fibers were determined by X-ray powder diffraction (XRD),as shown in Fig. 2. All XRD patterns were acquired using copper K-α radiation. Cu K-α radiation via a rotating anode was used; Cu K-α_2 and a continuously increasing background were removed from the XRD patterns using JADE software. The typical diffraction peaks at 2θ= 35.8°, 60.4°, and 72.1°, attributed to the (111), (220), and (311) lattices of 3C-SiC according to the JCPDS card (29-1129), respectively.

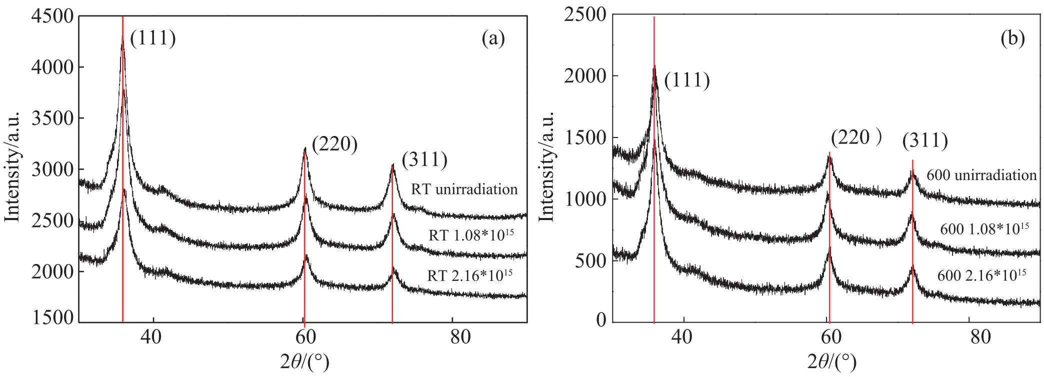

Fig. 2 (color online) XRD spectra of irradiated and non-irradiated SiC fibers. (a)at RT(b)at 600 ℃.

The XRD spectra of non-irradiated fibers at 600 ℃ show a significant evolution in comparison to non-irradiated one at room temperature. These differences concern the local structure modification. As the dose increases the peak intensity decreases, and the peak position moves to the right at the room temperature. The XRD spectra of irradiated fibers at 600 ℃ is different with the room temperature. In general XRD spectra suggest that SiC fiber has great irradiation resistance at the fluence of 2.16×10^{15} ions/cm^2.

References

[1] A. Jankowiak, C. Grygiel, I. Monnet, Y. Serruys, Nucl. Instr. Meth. B, 314(2013)144.

[2] L. Li, K. Jian, Y. F. Wang. Mater. Rev., 30(2016)308.

[3] W. J. Weber, F. Gao, R. Devanathan, et al., Nucl. Instr. Meth. B, 218(2004)68.

4 - 9 First-principles Investigation of Vacancy and Self-interstitial Atom Segregations at Grain Boundaries in Tungsten

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Materials served in nuclear energy systems usually expose to high irradiation doses of particles. Projectile particles lead to creations of a large numbers of vacancies (Vs) and self-interstitial atoms (SIAs) in materials. The SIAs may gather to form dislocation loops and stacking-fault tetrahedrons, and the Vs usually gather to form voids. These defects contribute to material swelling, hardening, amorphization and embrittlement, and may accelerate material failure under irradiation[1]. As recombination center of Vs and SIAs, grain boundaries (GBs) are able