concentration of vacancy-type defects, the S parameter is bigger than that of non-implanted sample.

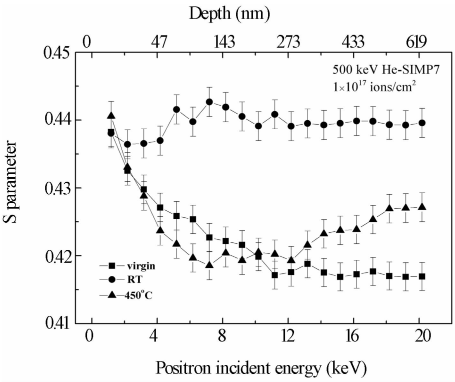

Fig. 1 The S parameter of irradiated samples as a function of the positron incidence energy.

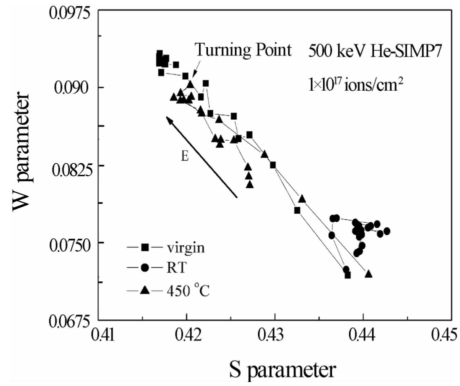

Fig. 2 S parameter of irradiated samples as a function of W parameter.

Fig. 2 shows the correlation between the S and the W parameters for non-implanted sample and irradiated samples. It is clear in the figure that, the well linearity of S-W plot shows only one-type defects in the non-implanted sample. For the sample irradiated at RT, the points in the S-W plot are not in the same line, indicating that different kinds of vacancy-type defects exist in the sample. For the case of irradiation at 450 ℃, the S-W Plot show two lines, indicating that two different kinds of vacancy-type defects exist in the sample possibly.

3 - 22 Structural Changes and Defects Evolution in Ti_3AlC_2 Induced by 500 keV He-ion Bombardments

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Due to its good damage tolerance, excellent physical properties such as remarkable mechanical properties and thermal stability, Ti_3AlC_2 has been considered as fuel cladding or structural materials used in accelerator-driven sub-critical systems (ADS) and Gas-cooled Fast Reactor (GFR).

Irradiation experiments with 500 keV He-ion were performed with different fluencies of 1×10^{16} ions/cm^2 to 1×10^{18} ions/cm^2 (irradiated sample will be referenced as sample 1E18 for concise and this notation applied to other samples) at room temperature (RT) under 320 kV multi-discipline research platform for Highly Charged Ions equipped with an ECR (Electron Cyclotron Resonance) ion source in the Institute of Modern Physics, Chinese Academy of Sciences (IMP, CAS), Lanzhou. On the basis of SRIM-calculations, penetration depth of He-ion is estimated to be about 1524 nm and the maximum damage at a depth of about 1278 nm is about 52.0 dpa. All the samples studied in this work were characterized by low-incidence X-ray diffraction and analyzed by Doppler broadening of Positron Annihilation Spectroscopy (PAS).

Fig. 1(a) gives XRD diffraction patterns of the virgin sample and all irradiated samples. For sample irradiated at the lowest dose, sample 1E16, changes in peak positions and peak broadening could not be detected. For 5E16 sample and higher damage levels, a continuous drop of peak intensity and increase of peak width is found. For 1E18 sample, very broad peaks of (1 0 3) and (1 0 4) appear, which is attributed to some loss of crystallinity. Shifts of the (1 0 2) and (1 0 5) peaks in the opposite direction should be noticed, which may be linked to an appearance of a new phase TiC_x but not be induced by an expansion of unit cell along *c* axis. Moreover, two new peaks corresponding to the (0 0 2) peak of TiAl and the (2 2 0) peak of Ti_3AlC appear and become stronger with an increasing fluence. That indicates an irradiation-induced segregation especially for atom C plays a vital role in resulting in the formation of new phases.

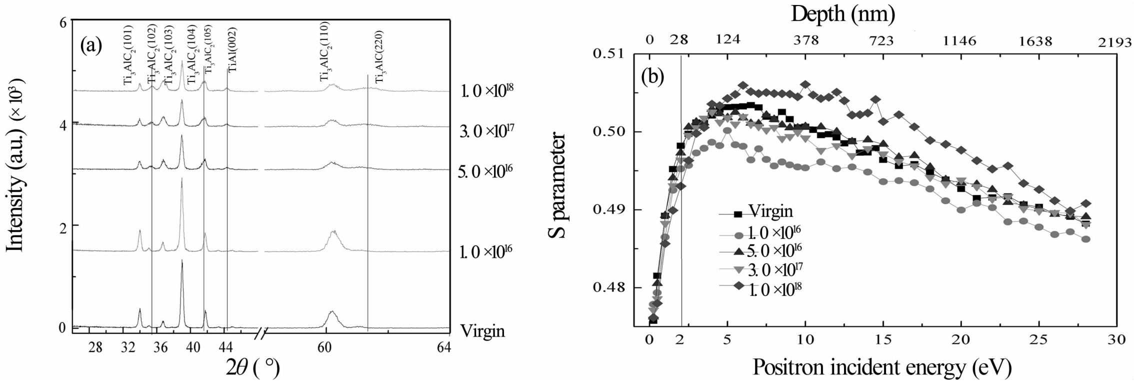

Fig. 1 (a) XRD patterns of samples irradiated by helium ions at various doses, (b) S parameter for the virgin and the samples irradiated by helium ions at various doses.

Fig. 1(b) shows S parameter as a function of positron incident energy for the virgin and the samples irradiated by helium ions at various doses using the positron incident energy as a running parameter. Compared to that of the irradiated samples, the S parameter of the virgin sample indicates a great amount of vacancy-type defects remaining in the sample before irradiation. However, for the sample irradiated at the lowest fluence, the S parameter is lower than that of the virgin when the permeation depth of positron is beyond ~28 nm, which should be related to a formation of He-Vacancy complexes preventing positrons from being trapped by defects. As the concentration of helium atoms increases with the fluence, helium atoms tend to aggregate with a formation of He_x-Vacancy complexes. As a result, more vacancies with a high density exist in the sample irradiated at the highest fluence, which contributes to the highest S parameter.

3 - 23 Corrosion of SIMP Steel in Static LBE at 450 ℃

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Due to its favorable thermal-physical and chemical properties, lead-bismuth eutectic (LBE) is one of primary candidate materials for coolant in advanced nuclear reactors including Accelerator Driven Sub-critical Systems (ADS). However, corrosion of structural materials presents a critical challenge in the use of LBE in advanced nuclear reactors[1]. Recently a new steel called SIMP steel was developed for candidate materials of ADS by Institute of Modern Physics, CAS and Institute of Metal Research, CAS. This paper reports the result of corrosion experiment of SIMP steel, exposed to static LBE at 450℃ with saturated oxygen.

The corrosion experiments of SIMP steel specimen were conducted at 450℃ for 500, 1000 and 2000 h respectively. The specimens without removing the adhered lead-bismuth were cut and polished for cross section examination by scanning electron microscopy (SEM) with energy dispersion X-ray (EDX). As shown in Fig. 1, the thickness of the corrosion layer of the specimen increases with increasing corrosion time and then the increase of the thickness of the corrosion layer is more and more slowly. Moreover, double corrosion layers are clearly observed at the specimen exposing to LBE for 2000 h in Fig. 1(c) and the thicknesses of outer and inner corrosion layers are near the same. A thin corrosion layer can be found in steel matrix surface, with a maximum measured depth of 4.4 m at 2000 h specimens and a minimum measured depth of only 1.2 m at 500 h specimens. In the same condition of the corrosion experiments, the measured depth of the corrosion layer for T91, made in Japan, is 7.6 μm in maximum and 2.6 μm in minimum respectively. Clearly, SIMP steel has a thinner corrosion layer than that of T91 in the same condition corrosion experiments.