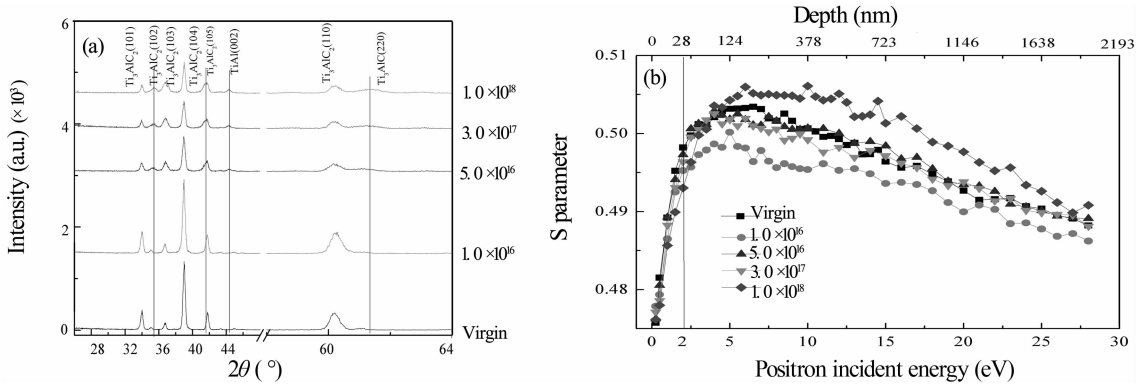

Fig. 1 (a) XRD patterns of samples irradiated by helium ions at various doses, (b) S parameter for the virgin and the samples irradiated by helium ions at various doses.

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.

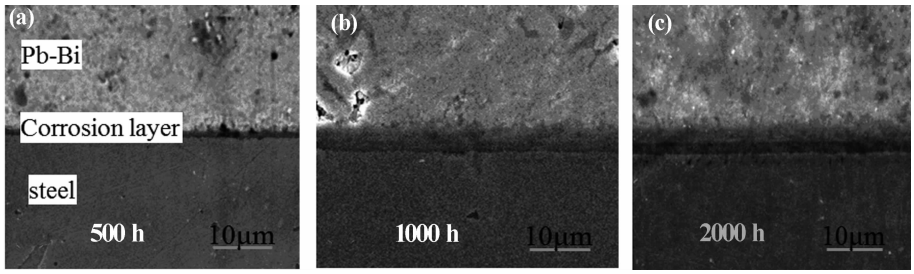

Fig. 1 SEM micrograph of cross-sections of SIMP steel after exposing to LBE at 450 ℃.

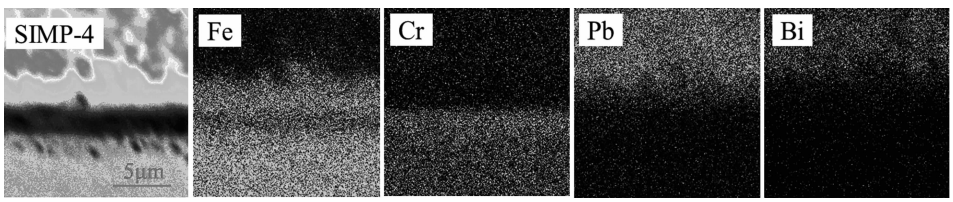

Fig. 2 EDX analysis of the cross-section of SIMP steel after exposing to LBE at 450 ℃ for 2000 h.

From the results for EDX analysis of SIMP steel after corrosion at 450℃, it is found that double corrosion layers, containing different element, is formed. Fe is observed in the outer corrosion layer and, Cr and Fe are observed in the inner corrosion layer. Furthermore, Pb and Bi penetrate into the outer layer. This result agrees with the result of outer magnetite and inner Cr Fe spinel formed during ferritic/martensitic steels corrosion in LBE[2-4]. The results for the elements mapping of SIMP steel after corrosion at 450 ℃ for 2000 h are shown in Fig. 2. According to the EDX line analyses, in comparison with total composition of steel matrix, Fe depleted in the whole corrosion layer and Cr is enriched in the inner oxide layer.

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3 - 24 Temperature Dependence of Cavity Swelling in RAFM/T91 and SIMP Steels under 196 MeV Kr-ions Irradiation

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Due to the properties of swelling resistant, low activation and high thermal conductivity, ferritic/martensitic (FM) steels are regarded as the candidate structural materials for GEN Ⅳ and fusion DEMO reactors[1]. It is well known that a mass of insoluble gas will be formed in materials by nuclear transmutation in nuclear energy systems. These insoluble gas atoms combined with defects which are produced during collision stage and surviving after the cooling stage will lead to cavity formation[2-4]. It will significantly alter the physical and mechanical properties of materials and can cause major difficulties in design of the advanced nuclear reactors[4]. In the present work, we focused on the temperature dependence of cavity swelling in steels under high energy Kr-ions irradiation.

Irradiation of specimen (RAFM/T91 and SIMP steels) was carried out in a high temperature chamber of sector focus cyclotron (SFC) in Laboratory of Heavy Ion Research Facility in Lanzhou (HIRFL), China. With 196 MeV Kr-ions delivered from the accelerator, besides one series sample irradiated to the ion fluence of 2.2×10^{16} ions/cm^2 at 450℃, the other two series specimens were irradiated to the same ion flu-