Effect of Ar ion irradiation on microstructure of the oxide film on Zr-1.0Sn-1.0Nb-0.3Fe alloy

Yuxi Song, Meiyi Yao*, Shitong Xu, Lijuan Hu, Yaoping Xie, Bangxin Zhou

Institute of Materials, Shanghai University, Shanghai 200072, China

songyuxi-@shu.edu.cn

**Correspondent: yaomeiyi@shu.edu.cn*

Abstract During the in-pile service of zirconium alloy cladding, not only the microstructure of the alloy but also the oxide film is affected by irradiation, and then affects the corrosion behavior of zirconium alloys. In order to study the effect of irradiation on the microstructure of the oxide film on zirconium alloys, the N36 alloys (Zr-1.0Sn-1.0Nb-0.3Fe, wt.%) plates are corroded in an aqueous solution of 360°C/18.6 MPa/3.5 ppm Li + 1000 ppm B for 30 days to prepare oxide film samples, and then the oxide film samples are irradiated with Ar^+ at 300°C with an irradiation damage dose of 12.0 dpa. The microstructure of oxide films before and after irradiation are characterized by transmission electron microscopy. The results show that oxide films before and after irradiation are composed of equiaxed grain and columnar grain, and there are “crescent” shaped cracks on the side near the outer surface of the second phase particles (SPPs) in the oxide film. The columnar grain in the oxide film after irradiation are more disordered, and there are more micro-pores and micro-cracks in the columnar grain zone. The hcp-$Zr(Nb,Fe)_2$ SPPs in N36 alloys undergo amorphous transformation and element diffusion during oxidation, but the hcp-$Zr(Nb,Fe)_2$ SPPs remain crystalline at the oxide film/metal matrix interface, which is more seriously damaged under irradiation. It indicates that the hcp-$Zr(Nb,Fe)_2$ SPPs in the oxide film are not prone to amorphization during irradiation, and also indicates that the amorphization of the hcp-$Zr(Nb,Fe)_2$ SPPs observed in the oxide film is mainly caused by oxidation.

Keywords Zirconium alloys; Corrosion; Ar ion irradiation; Oxide film; Microstructure