Effect of Ar^+ irradiation on the microstructure and corrosion resistance of Zr-Sn-Nb alloy

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Abstract Irradiation causes a large number of defects in the matrix and oxide film of zirconium alloys[1], which promotes the migration and diffusion of O^{2-} and corrosion media, then accelerates the corrosion of zirconium alloys[2]. To investigate the effect of irradiation on the microstructure and corrosion resistance of Zr-Sn-Nb alloys, we injected Ar^+ into ZIRLO alloys at an irradiation injection rate of 5.1×10^{15} ions/cm^2, and irradiated the original and post-irradiated samples at 360 ℃, 18.6 MPa, in aqueous solutions of 3.5 ppm Li + 1000 ppm B (alkaline water) and 400 ℃, 10.3 MPa steam (neutral water) for 300 days. Samples were taken and weighed at 30 d intervals, and the microstructures of the samples were analysed by means of XRD, SEM and TEM characterisation for 70 d, 190 d and 300 d, respectively, in order to observe the effect of Ar^+ irradiation on the corrosion resistance of Zr-Sn-Nb alloys in different corrosive environments. The results show that irradiation leads to amorphisation of the second phase particles, and the hcp-$Zr(Fe,Nb)_2$ second phase is more likely to form an amorphous state than the bcc-β-Nb second phase; it is found that both irradiation and corrosion cause amorphous transformation of the second phase, and at the same time, the amorphous phenomenon is often accompanied by the phenomenon of diffusion of the elements; within 300 d, in an alkaline environment, the damaging dose of Ar ion irradiation of 5 dpa on the ZIRLO alloy in alkaline environment within 300 d, the damaging dose of 5 dpa of Ar ion irradiation has little effect on the corrosion resistance of the ZIRLO alloy; while in neutral environment, irradiation has some improvement on the corrosion resistance of the alloy.

Keywords irradiation; corrosion; Zr-Sn-Nb alloy; second phase; oxide film thickness

Reference

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