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MS-14-P-2406 EFFECTS OF HYDROGEN AND RADIATION DAMAGE OF Zr-1% Nb and Zr-2.5% Nb

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Zirconium alloys are constitutive materials of several components of nuclear fission reactors. Thus, the study of their microstructure and mechanical properties, which are affected by radiation throughout useful life, is essential either for security reasons or eventually for the life extension of the utility.

In the core of a power reactor radiation damage as well as the hydrogen entry occur simultaneously, affecting the mechanical properties. Neutron irradiation that is generated within the reactor forms defects which eventually agglomerate acting as barriers to the movement of dislocations, increasing the mechanical strength, and a loss the ductility.

The aim of this work is to analyze microscopically the interaction between hydrides and crystal defects, in order to interpret how that affects the mechanical properties such as hardness and ductility [1]. The structures of Zr-2.5%Nb and In Zr-1%Nb hydrided were analyzed by transmission electron microscopy.

Zr-2.5%Nb specimens were irradiated at room temperature in the CNEA-RA1 nuclear reactor. They were placed in a capsule located in one of the reactor irradiation channels where the neutron where neutron flux is well known. In this case, neutron fluence was $1.8x10^{22}nm^{-2}$ after an irradiation of 500h δ and ε type hydrides parallel to [3 2 1 1] planes. This is consistent with results shown in the literature [2]. In the bright field micrograph “black dots” were observed as in the non irradiated materials. So we can identify them as hydrides and not as a result of the radiation damage. The irradiation dose was not sufficient to see the agglomerate of defects [3].

In Zr-1%Nb, TEM micrographs show hydrides present in the α-Zr matrix located transverse to the traction direction. These hydrides have been characterized as needle-shaped type ξ (zeta), with hcp structure, lattice parameters a= 0.33 nm and c=1.029 nm, corresponding to a trigonal crystal with space group P3m1. They are parallel to [0001] planes of α-Zr matrix [4].

At the present, more experiments are on going to clarify the presence and types of hydrides in both alloys.

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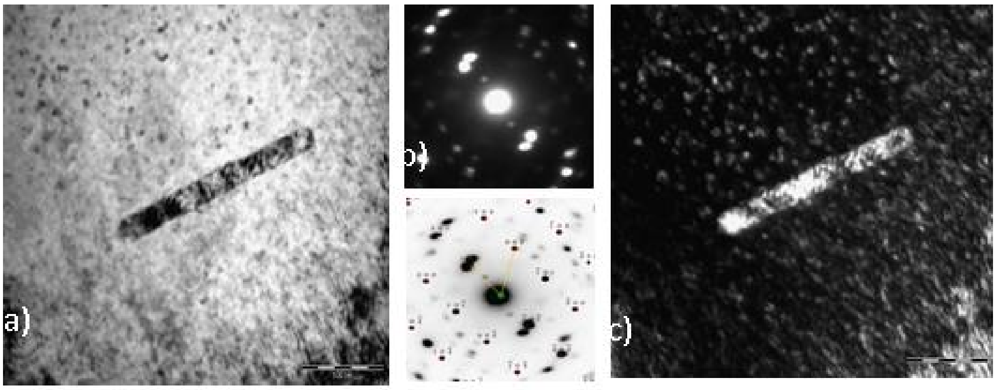

Fig. 1: a) Bright field TEM images of ε hydrides in a α-Zr matrix of irradiated Zr-2.5%Nb, b) electron diffraction pattern (zone axis [0 1 0]) of an identified ε hydride, c) dark field image of the hydride shown in b).

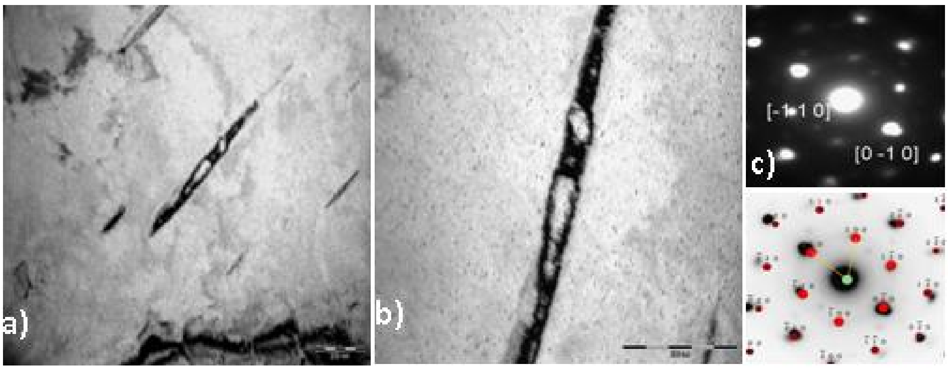

Fig. 2: a) TEM bright field images of ε hydrides in α-Zr matrix of Zr-1%Nb, b) enlarged images, c) electron diffraction pattern of the hydrides (zone axis [0001]).