MO-ZR INTERLAYER PREPARED BY ELECTRON BEAM AND ITS EFFECT ON THE THERMAL STABILITY OF THE MULTILAYER CR-MO-ZR SYSTEM*

E.A. PESTEREV, E.V. YAKOVLEV, V.I. PETROV, A.V. SOLOVYOV, M.S. SLOBODYAN, A.B. MARKOV

Tomsk Scientific Center of the Siberian Branch of the Russian Academy of Sciences; 10/4, Akademicheskii Prospekt, Tomsk, 634055, Russia

Zirconium-based alloys are widely used in nuclear power industry due to a set of unique properties. However, Zr oxidation kinetics at high temperatures can lead to accidents. The intensity of the Zr oxidation reaction increases in a steam environment at temperatures above 860 °C, which is followed by additional release of hydrogen and heat [1–2]. The concept of accident tolerant fuel being developed involves the use of surface modification technologies to protect Zr [3-4]. Cr-based coatings are promising candidates as a protective material, but the diffusion process at the interface between the Cr coating and the Zr substrate is a problem. A diffusion barrier can be used between the coating and the substrate to limit diffusion. Mo is one of the most appropriate materials for such barriers. Therefore, the presented study objective is the effect of heat exposure annealing on a Cr-Mo-Zr system with diffusion barriers of Mo and Mo-Zr alloy formed using a low-energy high-current electron beam (LEHCEB).

The samples were formed using the electron-beam machine "RITM-SP", which combines in one vacuum chamber a magnetron sputtering system and a source of LEHCEB [5]. In this work, a system consisting of a protective film (Cr), a barrier layer (Mo-Zr alloy) and a substrate (Zr) was formed. The Mo-Zr alloy was formed by the alternating operations of sputtering a Mo film on a Zr substrate and LEHCEB treatment. For comparison, a system with the magnetron sputtered pure Mo barrier was formed.

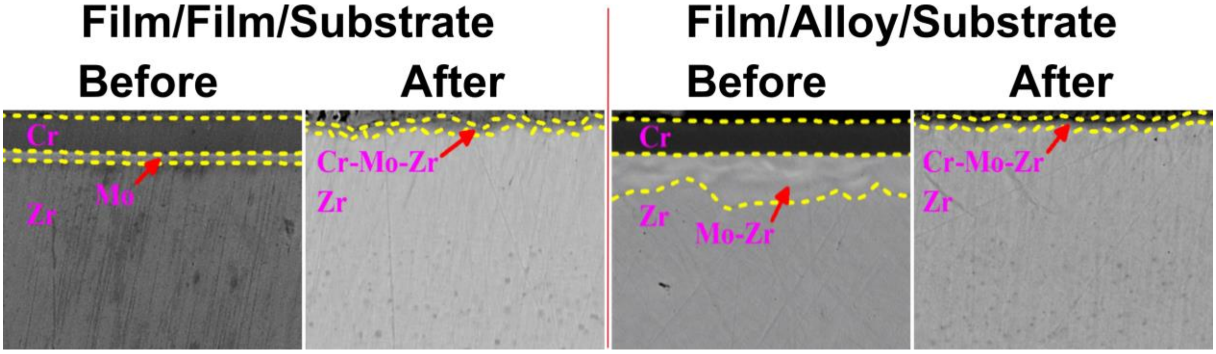

Fig.1. SEM systems cross-sections images before and after annealing at a temperature of 1100 °C.

The results in Figure 1 demonstrate that high-temperature annealing for 1 hour leads to a decrease in the thickness of the protective layer to 1.1-1.3 μm for both systems. At the same time, the average Cr content on the surface of the sample with barrier alloy was 72.5 ± 1.1 at.%, whereas on the sample with (layer-by-layer film deposition) the pure Mo barrier layer the Cr content was at 47.3 ± 0.4 at.%.

The obtained results allow us to conclude that the barrier layer in the form of Mo-Zr alloy allows to limit the diffusion of Zr to the surface. We assume that this result can be related to two possible reasons. The first one is the absence of columnar structure of the layer after LEHCEB treatment, and the second one is the high content of Mo-stabilized β-Zr phase.

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