C5-P-934201

SYNTHESIS OF MULTICOMPONENT FECRAL SURFACE ALLOY ON A ZIRCONIUM SUBSTRATE USING BY LOW-ENERGY HIGH-CURRENT ELECTRON BEAM*

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Zirconium-based alloys have served the nuclear industry for several decades due to their unique set of properties [1]. Under normal use, zirconium alloys form a protective layer of zirconium oxide against corrosion. However, at high temperatures, which can occur under accident conditions, zirconium alloys exhibit poor oxidation kinetics [2, 3]. The replacement of the Zr coating with an alternative coating that is resistant to oxidation has generated considerable interest since the accident at the Fukushima Daiichi nuclear power plant [4]. However, the complete replacement of Zr is a difficult task, since it will entail major changes in the design of the reactor core due to different mechanical and neutronic properties. Moreover, large-scale production of fuel claddings from alternative materials is a long-term proposal. An alternative approach is to coat the Zr with an oxidation resistant coating, which will increase the resistance to accidents and minimize the effect on neutron transparency. FeCrAl has been proposed as a coating material due to its excellent oxidation resistance and thermal stability [5, 6]. Al in alloys can form a stable layer of aluminum oxide. The oxidation rate of FeCrAl is at least two orders of magnitude lower than that of Zr [7].

In this work, we used the RITM-SP electron-beam setup with an explosive emission cathode and a plasma-filled diode generating a low-energy high-current electron beam (LEHCEB) [8]. This machine is equipped with a magnetron sputtering system that allows the formation of multicomponent surfacealloys. The surface alloy was formed by the co-deposition of Fe, Cr, and Al on a Zr substrate and subsequent irradiation with LEHCEB.

The surface FeCrAl alloy was studied and analyzed by X-ray phase analysis using synchrotron radiation of the VEPP-3 electron storage ring as part of the Central Collective Use Center of the SCST based on the UNU "VEPP-4 Complex - VEPP-2000" at the INP SB RAS. The morphology of the surface and cross section is considered. The elemental composition was analyzed.

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* The work was supported by the Ministry of Science and Higher Education of the Russian Federation (project No 075-15-2021-1348).