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Modified ZrO2 layer on ZIRLO to prevent Hydrogen Pick Up.

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Zirconium alloy is the main physical barrier between the coolant system and the fuel cell1. Its principal role is to keep the radioactive products produced during fission process (which is the power source in the nuclear reactor) contained in the fuel pin1. One of the problems in the nuclear industry is hydrogen absorption by zirconium alloys during operational and loss of coolant accident environment. This hydrogen diffusion into the fuel tube (zirconium alloys) leads to formation of brittle zirconium hydrides2. Theoretical predictions by Youssef and co-workers3 indicated that by doping the oxide layer on the zirconium alloy with chromium, the solubility of hydrogen in ZrO2 is greatly decreased which reduce the pick-up of hydrogen by the zirconium fuel tube.

In this study, compression plasma flow (CPF) was used to produce a chromium doped, oxidized ZIRLO surface layer. CPF is generated by quasi-stationary plasma accelerators with their own magnetic field. Such plasma flows are characterized by long life-time (about 100 μs) and high energy density absorbed by the target (from 10 to 100 J/cm2). When CPF interacts with the surface, the top layer is melted and a mixing process takes place in the layer. If a metal coating is deposited on the surface of the treated sample, the CPF impact will provide mixing of both coating and the substrate. A chromium coating with a thickness of 1 μm was deposited on the oxidized ZIRLO surface. The CPF treatment was done in a nitrogen atmosphere (400 Pa pressure). The chromium alloyed ZIRLO samples were sectioned using a diamond wire saw and mounted on a stub. A Helios NanoLab FIB SEM was used to cut transmission electron microscopy lamellae from specific areas of interest. The TEM lamellae were investigated in a JEOL 2100 LaB6 TEM operated at 200 kV.

The results of this investigation indicated that the alloying process of the oxide layer by the CPF method was successful. The thickness of the Cr modified oxide layer is about 2 μm. The hydrogen pick up investigation of the modified sample was carried on the special gas Reaction Controller complex. Results of hydrogen desorption from the chromium doped oxidized ZIRLO surface layers were found to be in agreement with the theoretical predictions by Youssef and co-workers3. Comparing the unmodified and modified sample the hydrogen desorption decreased by a factor of 26.

References

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Apply to be considered for a student ; award (Yes / No)?

No

Level for award;(Hons, MSc, PhD, N/A)?

N/A

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