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Improved oxidation resistance of zirconium at high-temperature steam

by magnetron sputtered Cr-Al-Si ternary coatings

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Abstract

Accident tolerant fuel claddings are extremely urgent to increase the safety margin of light water reactors. In this work, Cr-Al-Si ternary alloy coatings were proposed to increase high-temperature oxidation resistance of zirconium claddings. $\text{Cr}_{62.8}\text{Al}_{27.9}\text{Si}_{9.3}$ coatings were deposited on Zr coupons by magnetron sputtering, followed by evaluation of their oxidation resistance and adhesion strength under high-temperature steam. No oxidation of the Zr coupons underneath the coatings occurred in the 1000 °C steam for 15 min. In the 1200 °C steam for 30 min, both the weight gain and the thickness of the α -Zr(O) layer decreased 40% and 50%, related to those of the uncoated coupons, respectively. Moreover, the adhesion of coating and substrate was improved after the high-temperature oxidation, with the adhesion strength of the oxidized coating – Zr substrate more than ~50 N. It was further observed that the Al and Si atoms preferentially diffused outwards the surface to form a layer of oxides, and

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