

Impact of Surface Roughness on Oxidation Behavior of CoNiCrAlHf Alloys at High Temperatures and Elevated Pressures

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Abstract CoNiCrAlHf alloys are promising candidates for high-temperature applications due to their excellent corrosion resistance under extreme environmental conditions. In this study, we proposed a new method to understand the effect of surface roughness on the oxidation behavior of CoNiCrAlHf alloys with or without external pressure. The samples were prepared with three different surface roughness levels and subjected to a constant pressure of 2.5 MPa at a high temperature of 1050 °C for 430 h. The oxidation behavior was analyzed using energy dispersive X-ray spectroscopy (EDS) and X-ray diffraction (XRD) combined with scanning electron microscopy (SEM). The results showed that the oxide scale thickness of the rough surface ($R_a = 76.0$ nm) was significantly higher than that of the smooth surface ($R_a = 13.0$ nm). In addition, the rough surface exhibited microscopic defects and diffusion within the oxide scale, while the smooth surface showed more uniform scaling. Under the common conditions of high stress and surface roughness, the oxide scale cracked and fractured due to pressure and roughness. These results highlight the important role of surface roughness and external pressure in affecting the oxidation resistance of CoNiCrAlHf alloys and provide valuable insights for improving the performance of alloys in high-temperature environments. Additionally, the DFT calculation was used to investigate the effect of external pressure on oxide scale.

Keywords: Co-base alloy; oxidation; oxide scale; surface roughness; external pressure; DFT study