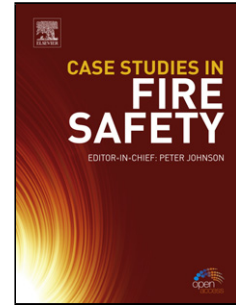


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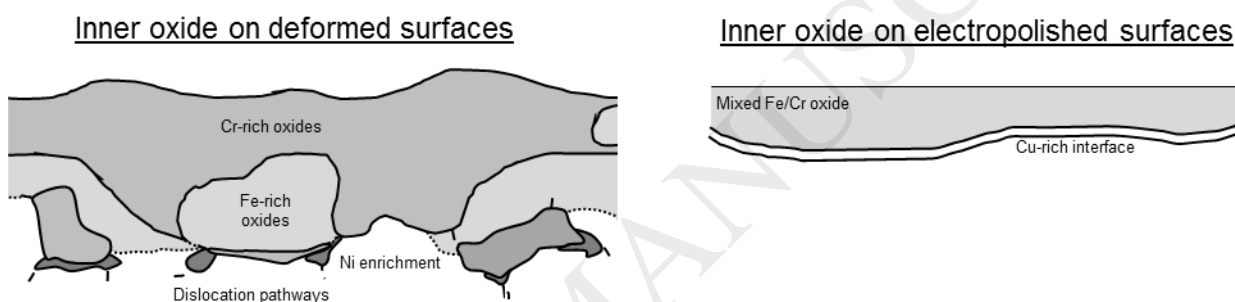
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Graphical Abstract



Highlights:

- The microstructure and microchemistry of the oxide depend on the surface condition.
- Oxidation mechanisms leading to the different oxide properties are proposed.
- On deformed surfaces, a nanostructured oxide develops due to selective oxidation.
- On electropolished surfaces, an equilibrium oxide phase develops uniformly.

Abstract

The oxide products found on austenitic stainless steels after high temperature exposures in nuclear reactor environments are well documented, but the mechanisms for the oxide formation are still ambiguous. One issue of practical importance is the role of surface deformation on the oxidation response. To address this question, short high-temperature water exposures were conducted on electropolished and ground surfaces of Type 304 stainless steel. Characterization of the developing oxide scales using transmission electron microscopy and atom probe tomography revealed significantly different responses from the two surface finishes. In the absence of sub-surface deformation, the oxide scale grows as an equilibrium phase of uniform composition with accumulation of Cu to the metal/oxide interface. In the presence of significant sub-surface deformation, a non-equilibrium nanostructured oxide scale develops as a result of selective oxidation along fast diffusion paths.

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