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Kok Boon Chong, Michael E. Fitzpatrick

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Evolution of Stress Fields and Phase Content in Corroded Zirconium Cladding Materials

Kok Boon Chong[a,c*], Michael E. Fitzpatrick[a,b†]

[a]Department of Engineering & Innovation, The Open University, Walton Hall, Milton Keynes, MK7 6AA, UK.
[b]Centre For Manufacturing & Materials Engineering, Coventry University, Engineering & Computing Building, Priory Street, Coventry CV1 5FB, UK.
[c]Jeffrey Sachs Center on Sustainable Development, Sunway University, No 5, Jalan University, Bandar Sunway, 47500 Selangor, Malaysia.

In this study, the evolution of stress fields and structural phase composition have been studied using Raman spectroscopy pre- and post-transition in the oxide layer of re-crystallised ZIRLO and recrystallised zircaloy-4 (Zr-4) after corrosion exposure in a static autoclave. The structural phase composition analysis showed that the proportion of the tetragonal zirconia phase on the surface decreased with increasing corrosion time. High compressive stresses were found in the thin oxide, increasing with corrosion time, reaching a maximum in the transition period and decreasing slightly after that. The results show the relationship between the crystallographic phase and the residual stresses developed in the oxide.

Keywords: Zr Corrosion, Stress Fields, Phase Content, Raman Spectroscopy.

1 Introduction

Zirconium (Zr) alloys are widely used in nuclear reactor applications such as fuel cladding / channel materials, owing to their low neutron absorption cross-section, high mechanical strength and good corrosion resistance. Corrosion in zirconium alloys is a complicated electrochemical process which is influenced by several factors, including the properties of the metal/oxide interface, water chemistry, pressure, irradiation, and time. Although many reported works[1-9] have studied numerous factors affecting the corrosion processes, and considerable understanding of the corrosion mechanisms have been secured, there are many effects that are still not fully understood: in particular, the relationships between the residual stresses that are generated between the oxide film and the substrate, the structural phase content, and the kinetics of corrosion. Better understanding can lead to the development of alloys

* kokboonc@sunway.eduy.my
† ab6856@coventry.ac.uk