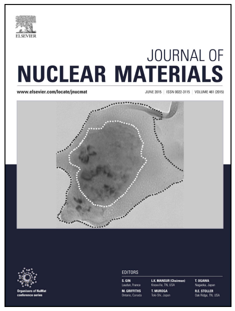
Accepted Manuscript



Modelling the interaction of primary irradiation damage and precipitates: Implications for experimental irradiation of zirconium alloys

A. Adrych-Brunning, M.R. Gilbert, J-Ch. Sublet, A. Harte, C.P. Race

PII: S0022-3115(17)30224-6

DOI: 10.1016/j.jnucmat.2017.10.022

Reference: NUMA 50554

To appear in: *Journal of Nuclear Materials*

Received Date: 12 February 2017

Revised Date: 15 July 2017

Accepted Date: 8 October 2017

Modelling the interaction of primary irradiation damage and precipitates: implications for experimental irradiation of zirconium alloys

A. Adrych-Brunning[a,*], M.R. Gilbert[b], J-Ch. Sublet[b], A. Harte[a], C.P. Race[a]

[a] *School of Materials, University of Manchester, Manchester, M13 9PL*
[b] *Culham Centre for Fusion Energy, Culham Science Centre, Abingdon, OX14 3DB, UK*

Abstract

Damage to materials by different irradiating particles is typically calibrated using displacements per atom (dpa). However dpa calculations usually neglect additional damage produced from primary interactions of irradiating particles with a bulk material and how localised microstructural features may change these interactions.

We investigate how the current standard measures of irradiation damage are affected when the presence and distribution of alloying elements in zirconium alloys is taken into account and show that the difference in primary interactions of neutrons and protons with alloying elements causes differing dpa rates relative to bulk zirconium. As such, using dpa in the matrix to correlate damage between proton and neutron-irradiated samples may imply different damage rates in localised microstructural features and therefore differences in the damage phenomena observed. We argue that when comparing the evolution of microstructural features under different irradiation types, the ~~defect density~~ displacement rate per unit volume may be a more useful measure of damage.

Keywords: Zirconium alloys, Damage quantification, Neutron Irradiation, Proton irradiation

1. Introduction

In the nuclear industry, Zr is an attractive material for fuel cladding because of its low thermal neutron absorption cross-section [1]. Alloying elements are added to pure Zr to improve its

*Corresponding author
Email address: alex.adrych-brunning@postgrad.manchester.ac.uk (A. Adrych-Brunning)