Accepted Manuscript

The influence of Ar^+ sputtering on the hydriding behavior of uranium

Ren Bin, Guangfeng Zhang, Hefei Ji, Lizhu Luo, Peng Shi, Xiaolin Wang

PII: S0022-3115(16)31305-8

DOI: 10.1016/j.jnucmat.2017.07.017

Reference: NUMA 50389

To appear in: *Journal of Nuclear Materials*

Received Date: 22 December 2016

Revised Date: 7 July 2017

Accepted Date: 7 July 2017

Please cite this article as: R. Bin, G. Zhang, H. Ji, L. Luo, P. Shi, X. Wang, The influence of Ar^+ sputtering on the hydriding behavior of uranium, *Journal of Nuclear Materials* (2017), doi: 10.1016/j.jnucmat.2017.07.017.

The Influence of Ar+ Sputtering on the Hydriding Behavior of Uranium

Ren Bin [a], Guangfeng Zhang [a], Hefei Ji [b], Lizhu Luo [a], Peng Shi [b], Xiaolin Wang [c*]

[a] Science and Technology on Surface Physics and Chemistry Laboratory, P. O. Box 9-35, Jiangyou 621908, Sichuan, China

[b] Institute of Materials, China Academy of Engineering Physics, P.O. Box 9-13, Mianyang 621900, Sichuan, China

[c] China Academy of Engineering Physics, Mianyang 621900, Sichuan, China

Abstract

The influence of superficial defects (induced by surface sputtering) on uranium oxidation and hydriding behaviors has been studied. Depleted uranium surface was etched by Ar^+ sputtering, the etched surface morphology was investigated by scanning electron microscope. The initial oxidation kinetics of sputtered uranium surface and mechanical polished uranium surface in ambient atmosphere were characterized using spectroscopic ellipsometry. As-polished and sputtered samples, as well as sequence sputtered samples ambient oxidized for different time, were compared in hydriding kinetics to investigate the co-influence of surface oxidation and superficial defects induced by Ar^+ ion bombardment. The morphologic characteristics of hydride sites in a few grains were also revealed and enhanced by sputtering, showing a network of fractures for fast hydride transportation.

Keyword

Depleted uranium, Hydrogen corrosion, Induction time, Ar^+ sputtering

1. Introduction

Uranium is an important material in military and energy industries. However, the storage and usage of uranium or uranium alloys components are at risk due to the high reactivity between uranium and ambient oxygen, water and hydrogen. Hydrogen corrosion is one of the most serious corrosion problems for damaging the integrity or decaying the mechanic properties of uranium. Due to the remarkable density mismatch between U (19.05 g/cm^3) and UH_3 (10.92 g/cm^3), when constrained by metal the growth of hydride precipitates would cause a 75% expansion in lattice, force the surrounding metal to plastic deform or even fracture, and inevitably cause damage or failure to components made of uranium or uranium alloys. What's worse, the pyrophoric uranium hydride is dangerous if exposed to ambient and also threatening the environment. Therefore, research on uranium-hydrogen (U-H) reaction is a persisting focus since Manhattan Project in 1940s, covering many aspects like reaction kinetics, metallography and surface chemical analysis, etc. Fruitful achievements have provided us a lot of fundamental understandings and many

* Corresponding author. E-mail address: xlwang@caep.cn (X. Wang)