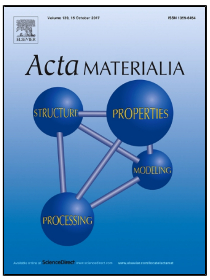
Accepted Manuscript



Microstructure and Fracture Toughness of Electrodeposited Ni-21 at.% W Alloy Thick Films

Denise Yin, Christopher J. Marvel, Fiona Yuwei Cui, Richard P. Vinci, Martin P. Harmer

PII:	S1359-6454(17)30850-9
DOI:	10.1016/j.actamat.2017.10.001
Reference:	AM 14099
To appear in:	*Acta Materialia*
Received Date:	24 July 2017
Revised Date:	20 September 2017
Accepted Date:	01 October 2017

Please cite this article as: Denise Yin, Christopher J. Marvel, Fiona Yuwei Cui, Richard P. Vinci, Martin P. Harmer, Microstructure and Fracture Toughness of Electrodeposited Ni-21 at.% W Alloy Thick Films, *Acta Materialia* (2017), doi: 10.1016/j.actamat.2017.10.001

Microstructure and Fracture Toughness of Electrodeposited Ni-21 at.% W Alloy Thick Films

Denise Yin[a,1*], Christopher J. Marvel[a], Fiona Yuwei Cui[a], Richard P. Vinci[a], Martin P. Harmer[a]

[a]Department of Materials Science and Engineering, Lehigh University, Bethlehem, Pennsylvania, USA
[1]Present address: U.S. Army Research Laboratory, Weapons and Materials Research Directorate, Aberdeen Proving Ground, MD USA
*Corresponding author – Email: deniseyin8@gmail.com

Abstract

Nanocrystalline Ni-W has been shown to exhibit properties superior to nanocrystalline Ni and coarse-grained materials, but studies regarding its fracture behavior are limited. This study investigates the fracture behavior of Ni-W, establishes structure-property relationships via correlation to the microstructure, and assesses the suitability of the micro-mechanical testing approach. As-deposited and various heat-treated Ni-21 at.% W films, processed by electrodeposition in a sulfate-citrate bath, were evaluated by *in-situ* microcantilever bend testing. Due to non-negligible plastic yielding, conventional linear elastic fracture mechanics was insufficient, and novel elastic-plastic fracture mechanics was necessary. Periodic partial unloading was implemented along with J-integral interpretation to monitor crack growth and quantify the fracture toughness. Each alloy was also examined with aberration-corrected electron microscopy to develop a complete understanding of the various microstructure and facilitate their correlation to the fracture behavior. Overall, fracture toughness measurements varied between 5.1 and 8.9 MPa√m depending on the heat treatment. Annealing significantly increased the microhardness but decreased the fracture toughness, thus implying a trade-off between the two.

Keywords: Nanocrystalline, micromechanics, fracture, nickel alloys, electron microscopy

1. Introduction

Nanocrystalline materials have attracted significant scientific interest over the last 30 years. Compared to their microcrystalline counterparts, nanocrystalline materials exhibit