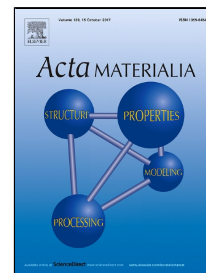


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Microstructure and Fracture Toughness of Electrodeposited Ni-21 at.% W Alloy Thick Films

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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 $\sqrt{\text{m}}$ 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

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