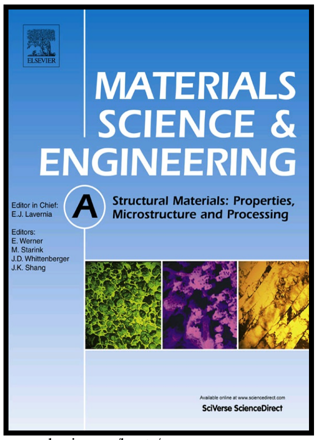
Author's Accepted Manuscript



www.elsevier.com/locate/msea

Microstructural Evolution of Rhenium Part I:Compression

Julian E.C. Sabisch, Andrew M. Minor

PII: S0921-5093(18)30853-0
DOI: https://doi.org/10.1016/j.msea.2018.06.057
Reference: MSA36612

To appear in: *Materials Science & Engineering A*

Received date: 22 March 2018
Revised date: 13 June 2018
Accepted date: 14 June 2018

Cite this article as: Julian E.C. Sabisch and Andrew M. Minor, Microstructural Evolution of Rhenium Part I:Compression, *Materials Science & Engineering A,* https://doi.org/10.1016/j.msea.2018.06.057

Microstructural Evolution of Rhenium Part I:Compression

Julian E.C. Sabisch, Andrew M. Minor*

Department of Materials Science and Engineering, University of California, Berkeley and National Center for Electron Microscopy, Molecular Foundry, Lawrence Berkeley National Laboratory

*Corresponding author. Andrew M. Minor, aminor@berkeley.edu

Abstract

A comprehensive study of the microstructural evolution of pure rhenium during compression has been conducted using TEM and EBSD analysis. Under compression, slip and dislocation plasticity was predominantly active in the low strain regime, with $\{11\bar{2}1\}\langle 11\bar{2}6\rangle$ twinning occurring at all strain amounts and dominating after yield. This is contrary to deformation twins typically being active during the initial low strain regime of twinning dominated metals. It was observed that twins could bypass grain boundaries, as previously reported. In addition, a mechanism of twins "jogging" along the c-axis past twin boundaries was observed using TEM. This mechanism allowed for multiple twin variants to be active within individual grains. Twin "jogging" helps to explain the excellent ductility in rhenium accommodating the lack of dislocation plasticity. Postmortem TEM imaging showed dislocation density steadily increased around the twins, a result of twin boundaries impeding dislocation slip, confirming observations seen in highly work-hardened tension samples. Additionally, dislocation populated twin boundaries have shown $\{11\bar{2}1\}\langle 11\bar{2}6\rangle$ type twins resist growing in size when surrounded by dislocations, tending instead to form new twins as strain increases.

Keywords: Rhenium; HCP; Twinning; Compression; Electron Microscopy

1. Introduction

Many of the better-known refractory metals, such as tungsten, tantalum, and ruthenium, suffer from low room temperature ductility, which limits their use in structural applications[1]. Rhenium is unusual among the refractory metals in that it has no ductile-to-brittle transition temperature, the highest work hardening of any pure metal, excellent creep resistance, and high yield strength throughout a very large range of operating temperatures [2-5]. Consistent with other hexagonal close packed (HCP) metals, Re relies heavily on twinning in order to