Coupled Diffraction and Microstructure-Aware Modeling Study of the Microstructure and Strength of Tantalum and BCC Steels During Deformation and Subsequent Recovery

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Abstract

Microstructure-aware models are necessary to extrapolate mechanical properties of materials to environmental conditions which are not easily reproduced in the laboratory, e.g. nuclear reactor environments. Elemental tantalum provides a relatively simple BCC system in which to develop a microstructural understanding of deformation processes which will then be applied to a much more complicated BCC steel alloy, HT-9. Neutron and high-energy x-ray diffraction (ND and HEXRD) techniques provide a non-destructive window into the microstructure that can be utilized *in-situ* under relevant environmental conditions. The evolution of internal stress, texture, lattice strain and dislocation density in each material was monitored through deformation and subsequent recovery and recrystallization with in-situ diffraction measurements. The observed data is used to develop both polycrystalline plasticity models and Discrete Dislocation Dynamics (DDD) models which, once validated, can be utilized for the prediction of component lifetime. The observed and simulated evolution of the microstructural features will be critically compared.

Keywords: tantalum, bcc metals, diffraction

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