Solute Interactions in Pure Vanadium and V-4Cr-4Ti Alloy* - D.T. Hoelzer, S.J. Zinkle, and A.F. Rowcliffe (Oak Ridge National Laboratory) and M.K. West (University of Tennessee)

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Extended Abstract

Room temperature electrical resistivity and microhardness measurements were performed on cold-worked (CW) pure vanadium; solution annealed and CW V-4Cr-4Ti (alloy), and fusion welded alloy over the isochronal annealing temperature range from 200°C to 1200°C. The four-point probe technique was used for measuring electrical resistivity and a Vickers pyramidal indenter with a 1 kg load was used for measuring microhardness on type SS-3 sheet tensile specimens.

The results suggested that differences in property behavior observed for the specimens from 200°C to 400°C were related to interactions between interstitial O, C, and N solutes and Ti solutes in the alloy. In the cold-worked vanadium specimen, the formation of interstitial solute atmospheres around dislocations in the substructure was attributed to the observed increase in hardness and decrease in electrical resistivity. Calculations showed that the interstitial solutes possessed sufficient mobility at the lower temperatures to account for this type of thermally activated process. No significant increase in hardness was observed in the different alloy specimen conditions over this temperature range. However, differences in electrical resistivity were observed for these specimens. The resistivity and hardness data was interpreted as showing a cumulative effect that was balanced between processes involving the clustering of interstitial solutes around immobile Ti solute atoms (annealed alloy condition) and formation of atmospheres around dislocations (cold-worked and welded alloy conditions).

The measured property data for isochronal annealing temperatures above 400°C showed three distinct trends that were observed to depend on the composition and condition (i.e. deformed, annealed, or welded) of the specimens. The analysis of the three trends suggested that; (1) recovery of dislocation structures began in the CW vanadium, CW alloy, and welded alloy specimens at temperatures above 400°C, (2) a precipitation reaction occurred in the CW alloy and welded alloy specimens between ~600°C and 800°C, and (3) recrystallization and grain growth processes occurred in all the specimens above ~900°C. The results that supported the precipitation reaction consisted of decreasing electrical resistivity from 600°C to ~800°C and of corresponding maxima in hardness near 700°C for the CW alloy and welded alloy specimens. The property measurements for the CW vanadium and annealed alloy specimens showed no evidence of the precipitation reaction.