INFLUENCE OF NICKEL AND BERYLLIUM CONTENT ON SWELLING BEHAVIOR OF COPPER IRRADIATED WITH FAST NEUTRONS - B. N. Singh (Risø National Laboratory), F. A. Garner and D. J. Edwards (Pacific Northwest National Laboratory) and J. H. Evans (University of London)

To be submitted for publication in the Journal of Nuclear Materials.

Extended Abstract

In the 1970's, the effects of nickel content on the evolution of dislocation microstructures and the formation and growth of voids in Cu-Ni alloys were studied using 1 MeV electrons in a high voltage electron microscope. The swelling rate was found to decrease rapidly with increasing nickel content. The decrease in the swelling rate was associated with a decreasing void growth rate with increasing nickel content at irradiation temperatures up to 450°C. At 500°C, both void size and swelling rate were found to peak at 1 and 2% Ni, respectively, and then to decrease rapidly with increasing nickel content. However, recent work has demonstrated that the swelling behavior of Cu-5%Ni irradiated with fission neutrons is very similar for that of pure copper. The present experiments were designed to investigate this apparent discrepancy.

Five Cu-x%Ni alloys, where x = 0.17, 1.0, 2.0, 5.0, and 10 weight percent, were irradiated in Cobra-1A irradiation experiment in the EBR-II reactor at about 390°C and 500°C to a dose level of ~11.3 dpa (NRT). These copper alloys were from the same stock which was used for the 1 MeV electron irradiations. Specimens of Cu-0.5 wt% Be were also included in the irradiation experiment. Transmission electron microscopy was used to determine the effect of irradiation on dislocation microstructure and void swelling.

Results show that both the void size and swelling first increase between 0 and 1%Ni and then decrease rather rapidly with increasing nickel content. This behavior is very similar to that observed under 1 MeV electron irradiation at 500°C. Furthermore, the decrease in swelling in the present experiments occurs via a decrease in the void size as was observed in the earlier 1 MeV electron irradiations. This temperature shift can be understood in terms of a very large difference in the damage rate between the 1 MeV electron and fission neutron irradiations. The fact that at high doses the swelling rate in pure copper and Cu-5%Ni is very similar during neutron irradiation may be due to the loss of nickel from the matrix to void surfaces and grain boundaries via radiation-induced segregation. The reduced concentration of nickel in the matrix and the low damage rate during neutron irradiation would reduce the dynamic concentration of metastable clusters/precipitates in Cu-Ni alloys. Hence, a decrease in the swelling resistance occurs since these metastable clusters/precipitates act as recombination centers.