THE RESISTIVITY OF CuAu DURING NEUTRON IRRADIATION

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February 26, 1952

Naval Reactor Program
Contract AT-11-1-GEN-14

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Specimens of initially ordered and disordered copper-gold alloy (Cu₃Au) have been exposed to the neutron flux of a graphite moderated nuclear reactor. The two specimens were irradiated at the same time and at the same position in the reactor. Their temperature was controlled at 80°C. Electrical resistivity measurements were made on the specimens during the course of the irradiation. The results are plotted in Figure 1 as a function of the integrated thermal neutron flux (nvt), which was chosen as a convenient measure of the radiation dose. The measurements extend up to a total nvt = 6.5 x 10¹⁹ neutrons/cm².

The resistivity of the disordered specimen decreased continuously until nvt reached 4 x 10¹⁹ and remained essentially constant from then on at a value 7% below the initial value. The resistivity of the ordered specimen dropped rapidly at first, passing through a minimum 3% below the initial value at an integrated flux of 0.4 x 10¹⁹. Thereafter the resistivity climbed linearly with the flux, reaching a value 23% above the initial value. The discontinuities in the ordered curve are caused by small decreases in the resistivity during reactor shutdowns.
It is of interest to compare the present results with those of other investigators. Siegel made before and after irradiation measurements on specimens exposed in a nuclear reactor at a temperature near 40°C. He found that the resistance of the initially disordered specimen remained substantially unchanged. The ordered specimen resistivity increased from the beginning, approaching that of the disordered after long times under irradiation. Because of the pre-post nature of this experiment, a minimum in the ordered resistivity at small nvt would not have been detected. Blewitt and Coltman have found a decrease in the resistivity during irradiation of an initially disordered specimen maintained at 200°C. Adam and Dugdale report results similar to ours on an ordered sample.

Siegel's experiment suggested that the effect of neutron bombardment was purely a disordering one. Subsequent work indicates that this simple interpretation does not hold for all temperatures and fluxes. Assuming that the resistance of the alloy is a measure of its degree of order, our results suggest that reactor irradiation has both ordering and disordering tendencies.

During irradiation, mercury is produced by thermal neutron absorption in gold. At an integrated thermal neutron flux of $6 \times 10^{19}$, about one out of every 200 gold atoms has been converted to mercury. The possibility that mercury contributes to the disordering is being investigated.
References


Caption for Figure

Figure 1. The resistivity of initially ordered and disordered specimens of Cu3Au during neutron irradiation at 80°C. The radiation dose is measured in terms of nvt, the integrated thermal neutron flux (neutrons/cm²).