The Resistivity of Cu_3Au during Neutron Irradiation

H. L. Glick, F. C. Brooks, W. F. Witzig, and W. E. Johnson
Westinghouse Electric Corporation, Pittsburgh, Pennsylvania
(Received May 6, 1952)

Samples of initially ordered and disordered Cu_3Au have been irradiated in a nuclear reactor at 80°C. Continuous in pile, electrical resistivity measurements suggest that pile irradiation has both ordering and disordering tendencies.

SPECIMENS of initially ordered and disordered copper-gold alloy (Cu_3Au) 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±5C°, except during pile shut-down when the temperature dropped as low as 20°C. Electrical resistivity measurements were made on the specimens during the course of the irradiation. The results are plotted in Fig. 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 $nvt=6.5\times10^{19}$ neutrons/cm^2.

The resistivity of the disordered specimen decreased continuously until *nvt* reached 4×10^{19} and remained essentially constant from then on at a value 7 percent below the initial value. The resistivity of the ordered specimen dropped rapidly at first, passing through a minimum 3 percent below the initial value at an integrated flux of 0.4×10^{19}. Thereafter, the resistivity climbed linearly with the flux, reaching a value 23 percent above the initial value.

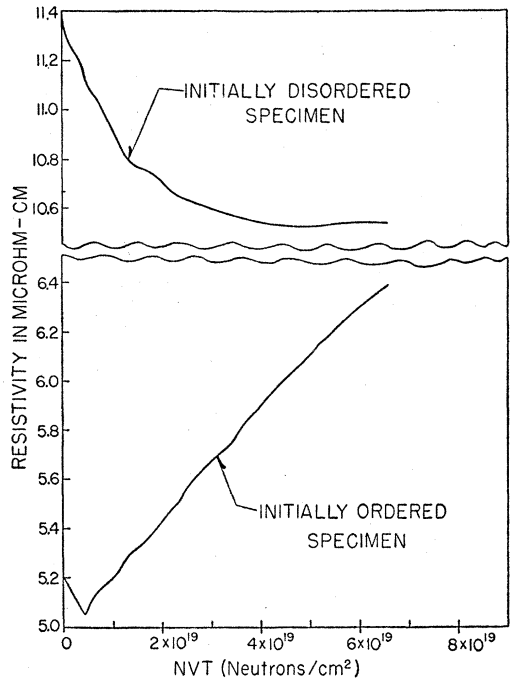

FIG. 1. The resistivity of initially ordered and disordered specimens of Cu_3Au during neutron irradiation at 80°C. The radiation dose is measured in terms of *nvt*, the integrated thermal neutron flux (neutrons/cm^2).

It is of interest to compare the present results with those of other investigators. Siegel[1] 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[2] have found a decrease in the resistivity during irradiation of an initially disordered specimen maintained at 200°C, while Martin *et al.*[3] have observed little change in this resistivity using cyclotron irradiations at or below room temperature. Adam and Dugdale[4] 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 indicated 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 6×10^{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.

[1] S. Siegel, Phys. Rev. **75**, 1823 (1949).
[2] T. H. Blewitt and R. R. Coltman, Oak Ridge National Laboratory (private communication, December 1951).
[3] A. B. Martin *et al.*, Phys. Rev. **81**, 664 (1951).
[4] J. Adam and R. A. Dugdale, Nature **168**, 582 (1951).