COMMENT

PROC. INT. CONF. CRYST. LATT. DEF. (1962)
J. PHYS. SOC. JAPAN **18** SUPPL. III (1963)

Irradiation-Induced Annealing of Stacking-Fault Tetrahedra in Gold*

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The stacking-fault tetrahedra introduced into a gold specimen by quenching from close to the melting point and annealing at 100°C are stable up to about 650°C (ref 1). Above this temperature they anneal out rapidly, with an activation energy of about 4.8 ev and a frequency factor in the region of 10^{23} (ref 2). The fact that this activation energy is close to that of interstitial self diffusion suggests that the annealing mechanism may involve the capture by the tetrahedra of interstitials, sufficient in number to initiate break-up. This process could then be completed by vacancy emission (ref 3).

This paper reports the results of similar experiments in which irradiation-produced instead of thermally-produced interstitials are used to initiate break-up. A further difference is that in this experiment the irradiation temperature, below 50°C, was too low for vacancy emission, so the entire process was due to interstitial absorption.

Electron microscope specimens about 1000 Å thick were examined before and after irradiation with alpha-particles. Fig. 1 shows a typical pair of photographs of the same region of foil obtained in this way. The irradiation is seen to anneal out most of the tetrahedra, and to produce a high density of black spot defects. Defects similar in appearance and size to the latter have been observed in quenched gold and have been tentatively identified as clusters of about 400 vacancies.

The mean time, t, required for the break-up of a tetrahedron can be shown to be given by $t=n/FAV_c$ where n is the number of interstitials that must be absorbed, F is the flux of alphas, A is the mean number of interstitials generated per unit distance in the foil, and V_c is the tetrahedron capture volume for interstitials. Using $n\sim150$ (ref 3) and putting V_c roughly equal to the physical volume of the tetrahedron, the flux corresponding to Fig. 1 gives $t=5$ seconds. In fact the irradiation time was 30 seconds, so it is not surprising that very few of the tetrahedra survive.

Fig. 2 shows the time variation of the concentration of tetrahedra and black spot defects in a specimen irradiated at a lower flux. In this case $t=1.4$ hours. This is about one tenth of the time required to anneal out all of the tetrahedra.

The results of these experiments suggest that

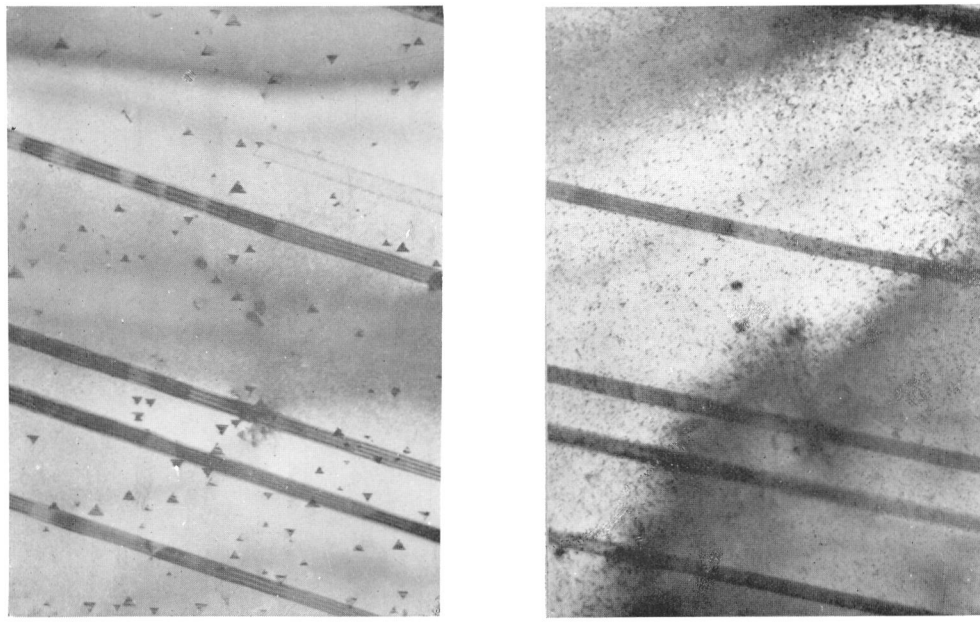

Fig. 1. An area of gold foil, containing stacking-fault tetrahedra, before and after irradiation with alpha particles at a flux of 5.7×10^{11} $cm^{-2}sec^{-1}$.

* Presented by D. G. Brandon

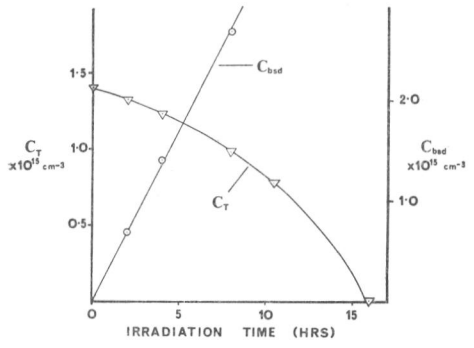

Fig. 2.

the interstitials generated during irradiation migrate to the tetrahedra and gradually annihilate them. The irradiation-produced vacancies, being less mobile, remain localized near their point of production and cluster to produce the black spot defects.

The authors are indebted to Dr. D. G. Brandon for communicating this paper.

References

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PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON CRYSTAL LATTICE DEFECTS, 1962, CONFERENCE JOURNAL OF THE PHYSICAL SOCIETY OF JAPAN VOL. 18, SUPPLEMENT III, 1963

Defect Configurations in Heavy-Atom Bombarded BeO

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Collision cascade calculations for krypton and iodine bombardment of BeO (wurtzite structure) were made using the hard-sphere scattering model. A Bohr screened potential was used to determine the distance of closest approach. Bombardment energies in the range 0.5–50 keV were considered. A significant part of both primary and ejected atom trajectories were restricted either to tunnels defined by successive hexagonal atom rings or to a region between two adjacent parallel atom planes. In these instances the stopping power was relatively small and the penetration anomalously large. The number of stable displacements in a cascade was found to be 31% and 35% of the number of displaced atoms given by the Seitz-Harrison and Kinchin-Pease models, respectively. The number of replacement collisions increased linearly with bombardment energy. The displaced atom energy spectra terminated below the hard-sphere collision threshold energy for each atom type.

1. Introduction

Defect configuration computations were performed using the hard-sphere scattering approximation and an energy-dependent distance of closest approach determined by a Bohr screened potential. It was assumed that a collision cascade could be described in terms of a branching sequence of binary collision events between an energetic incident atom and a stationary target atom, as in Yoshida's[1] calculations for germanium. An IBM 7090 computer was used for all calculations. Initially perfectly ordered arrangements of beryllium and oxygen atoms on both a square planar lattice (SPL) and the real BeO wurtzite lattice (WL) were bombarded with iodine and krypton atoms having energies in the range 0.5–50 keV.

A novel feature of these calculations is that both the primary bombarding atom and each knock-on atom ejected during the cascade were presented with the current damage state of the crystal each time their target atom selected. The true chronology of cascade development was approximated by scheduling collisions in a local region such that the next collision considered was that for the atom moving with the largest *veloci-*