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RADIATION DAMAGE IN PLATINUM

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The assignment of the annihilation of specific defects to various stages of recovery in irradiated materials is subject to some doubt and controversy.¹ This is especially true of stages III and IV of the recovery spectrum, which for platinum occur at 90 to 190°C and 250 to 450°C, respectively.² We would like to offer direct evidence that in neutron-irradiated platinum, irradiated below stage III,³ clusters of interstitials and clusters of vacancies are present.

The experiment was conducted in the following manner: Chemically pure platinum of 99.999% purity was irradiated at 75°C in a reactor to a total irradiation of 10^{18} nvt. Examination of this platinum wire was then undertaken in a field-ion microscope⁴ with the specimen coupled to a bath at 78°K. Compared to similar specimens, which were not irradiated, the irradiated materials exhibited a few features which we think can only be associated with the presence of interstitial and vacancy clusters. These are as follows:

A. Bright spots appear characteristically in the pattern and alternate with regions of relative perfection at the tip, Fig. 1, and throughout the volume. The size of these bright spots—a few atom diameters—as well as the enhanced local intensity associated with them indicate a local disturbance of the normal arrangement of the material.

B. These bright spots can disappear with

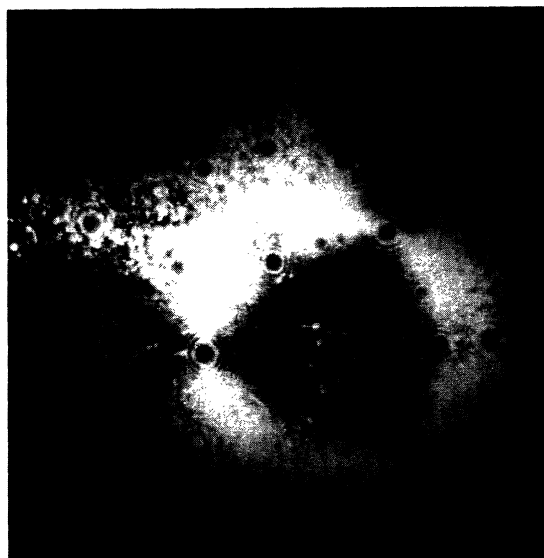


FIG. 1. Neutron-irradiated platinum, 10^{18} nvt, showing clusters of interstitials.

the evaporation of atoms when the specimen is held in an electric field slightly below the field necessary for evaporation of atoms not associated with enhanced intensity. This is done by field-evaporating the specimen and slowly lowering the voltage until the field ion pattern becomes stable, and then simply waiting for the removal of a bright spot. From this we conclude that the bright spot is associated with some strain in the lattice, which

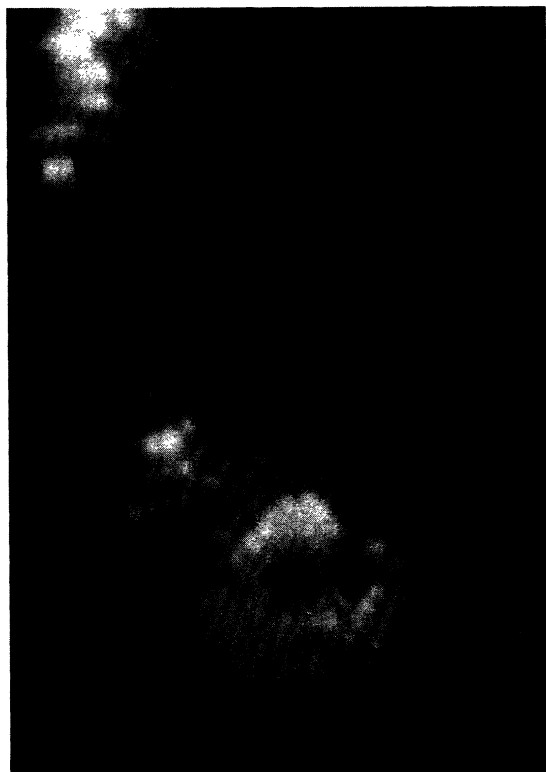


FIG. 2. Neutron-irradiated platinum, 10^{18} nvt, showing clusters of vacancies.

gives a bulge at the surface and thus the increased intensity. Further, no such bright spots appear in a similar experiment in the blank material, nor in regions removed from an area of extensive damage in the same material.

C. Impurities cannot conceivably account for the density of spots observed since such bright spots do not appear in the blank specimens.

D. The observed shapes of the bright spots

—lines, triangles—are not observed in any field evaporation of annealed platinum, nor are they in regions removed from a heavily damaged section, which is accessible through field evaporation.

E. An example of a vacancy cluster in a tip made from the same irradiated wire as used in the above observation is shown in Fig. 2, in which one clearly distinguishes missing atoms. Thus, by elimination, the only other defect that these additional bright spots can correspond to is that of an interstitial (or clusters thereof).

It is interesting to note that, although we have observed the above-mentioned multivacancy clusters, no instance of isolated vacancies or divancy clusters has been observed in the examination of a large number of irradiated specimens. This has some bearing on various interpretations of the recovery spectrum of irradiated materials and will be explored in a separate publication.

It is a pleasure to express our thanks to our colleagues, in particular E. S. Machlin, who has encouraged us throughout these experiments and supplied facilities for this research. We are also grateful for the continued support of this research through the National Aeronautics and Space Administration.

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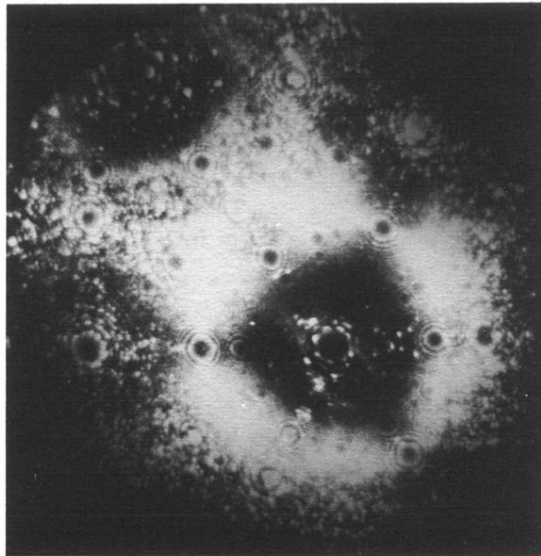


FIG. 1. Neutron-irradiated platinum, 10^{18} *nv*t, showing clusters of interstitials.



FIG. 2. Neutron-irradiated platinum, 10^{18} *nvt*, showing clusters of vacancies.