count rate of 0.58 ± 0.20 count/sec. The experimental count rate at 120 ± 70 km is 0.83 ± 0.08 count/sec. Allowing for 0.1 count/sec background these agree well. The calculated count rate decreases from 0.58 to 0.27 at 1000 km and 31°N. A least-squares fit to the experimental data gives a decrease from 0.85 to 0.50 count/sec which agrees quite well with the calculated count rate plus background. We therefore feel that the experimental data on Fig. 2 from 100 km to 1000 km are due mostly to leakage neutrons from the atmosphere of the earth plus a not very well-known background, and the earlier calculations on the neutron leakage are in good agreement with these measurements. This means also that the other sources of neutrons in space near the earth are substantially smaller than the atmospheric leakage source.

Victor Kiernan, Norman Jenson, Donald Peters, and Leonard Gibson of LRL did the electrical engineering of the detection instruments. Nicholas Yanni and Robert Henderson of LRL did the detector mechanical engineering and environmental testing. Captain Alex Kuros and Mr. Olin Long of AFSWC built and tested the telemetering equipment. Also, Major Lew Allen of AFSWC gave his valuable help in carrying out the experiment.

*Work was performed under the auspices of the U. S. Atomic Energy Commission.

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DISLOCATION LOOPS DUE TO QUENCHED-IN POINT DEFECTS IN GRAPHITE

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(Received June 20, 1960)

Small prismatic dislocation loops, presumably due to the precipitation of vacancies, were first observed in NaCl by means of decoration techniques.[1,2] Unambiguous evidence that, on quenching, dislocation loops are formed in metals (Al, Cu) was presented by Hirsch[3] using transmission electron microscopy. Large dislocation loops due to point defects formed during cold work were found in zinc.[4]

Evidence is presented here that on quenching followed by annealing, dislocation loops are formed in natural graphite, and that the point defects involved are vacancies rather then interstitials.

The graphite crystals were treated in the following way. They were first heated in a vacuum of 10^{-5} mm by means of electron bombardment to around 2700-3000°C for 2 minutes. The electron beam was then switched off suddenly and the crystal flakes were allowed to cool. In about 4 seconds the temperature was below 600°C as judged by pyrometry. After this treatment no change in aspect was found as observed in the electron microscope. After annealing the specimens in a vacuum at 1200°C, it was, however, found that they contained large dislocation loops in the c plane of the kind shown in Fig. 1, which is a transmission electron micrograph of a thin cleavage flake. The loops contain a stacking fault, as can be concluded from the contrast shown in Fig. 1. When using the $(11\bar{2}0)$ reflection to make a dark-field image, it is found that the loop exhibits an inverted line contrast as shown in Fig. 2(b). This observation proves that the Burgers vector is not perpendicular to the c plane. The structure of the dislocation loop is therefore most probably as shown schematically in Fig. 3(a), assuming the point defects to be vacancies. The Burgers vector has a component

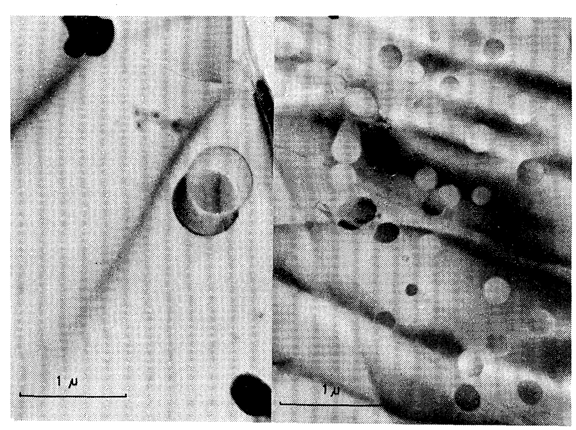

FIG. 1. Quenched-in dislocation loops in graphite. The loops exhibit stacking fault contrast.

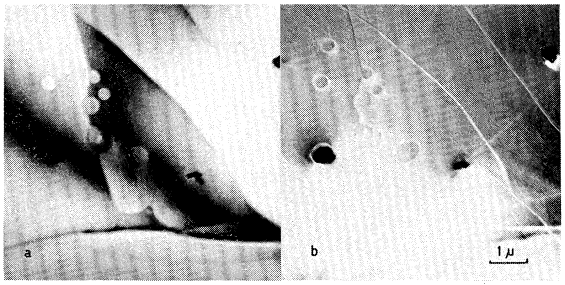

FIG. 2. Normal image (a) and dark-field image (b), using the (11$\bar{2}$0) reflection. The dislocation line shows up in inverted contrast. This observation eliminates the possibility of a Burgers vector perpendicular to the c plane.

normal to the c plane of $c/2$ and a component in the c plane equal to the nearest neighbor distance. The loop therefore contains a low-energy single stacking fault, i.e., one layer in rhombohedral stacking as shown in Fig. 3(a). This stacking fault cannot be eliminated by glide. Moreover, since the stacking fault energy is very small[5] ($3 - 5\times10^{-2}$ erg/cm^2), the tendency to do so would be negligible anyhow.

If the point defects were interstitials, the dislocation loops would have the structure of Fig. 3(b). The loop now contains a stacking fault of roughly three times larger energy, since there are three violations of the stacking sequence against one in the first case.

The passage of a partial dislocation with a Burgers vector connecting nearest neighbor carbon atoms could transform this stacking fault into a single one, i.e., of the same type as shown in Fig. 3(a). Since the stacking fault energy γ is so small, the shear stress γ/b is not sufficient to nucleate the partial dislocation and the loop will therefore remain as shown in Fig. 3(b), i.e., with a Burgers vector $\frac{1}{2}c[0, 0, 0, 1]$, i.e., normal to the c plane. Since we find experimentally that the Burgers vector is inclined with respect to the c plane, we have rather strong evidence that the point defects giving rise to the loops are vacancies. We have here an interesting case where the distinction between vacancies and interstitials can be made.

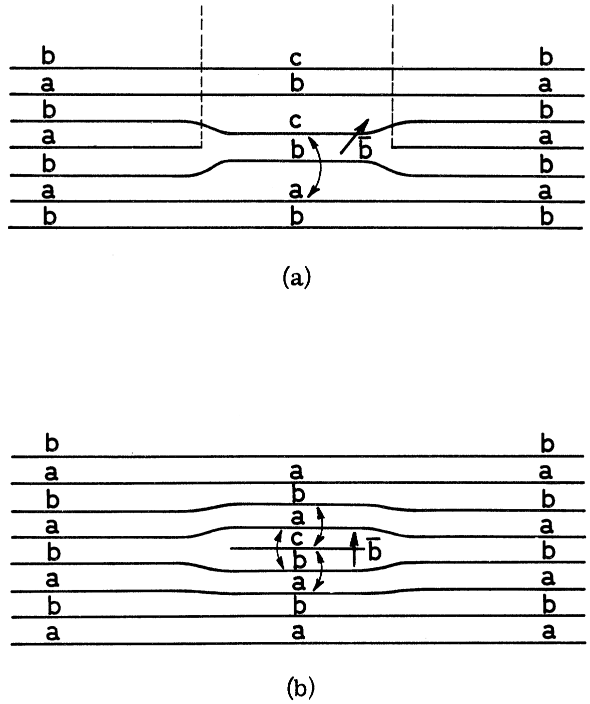

FIG. 3. (a) Schematic view of dislocation loop due to the precipitation of vacancies. The Burgers vector is inclined with respect to the c plane. (b) Schematic view of dislocation loop due to the precipitation of interstitials. The Burgers vector is perpendicular to the c plane.

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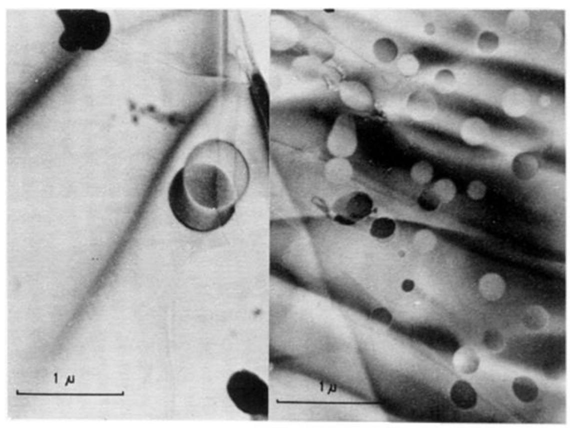

FIG. 1. Quenched-in dislocation loops in graphite. The loops exhibit stacking fault contrast.

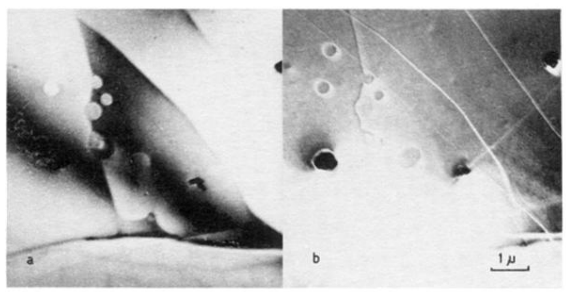

FIG. 2. Normal image (a) and dark-field image (b), using the $(11\bar{2}0)$ reflection. The dislocation line shows up in inverted contrast. This observation eliminates the possibility of a Burgers vector perpendicular to the c plane.