should be smaller than the one we used in order to obtain the best ratio of pulse amplitude to total energy absorption. The optimum length is one just long enough to completely contain the ultrasonic pulse so that the output reaches its full amplitude. Results on optimization of the detector, together with a detailed analysis, will be reported at a later date.

The advent of an intensity (rather than integrated amplitude) detector will facilitate experiments which have not heretofore been possible. As an example, it will allow observation of incoherent acoustic energy, important in the study of boundary scattering. Absolute ultrasonic energy measurements are also possible, since the microwave power absorbed may be calibrated if the transition probability and numbers of spins are known.

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SURFACE STATES ON CLEAVED SILICON*

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Measurements of surface band structure on silicon (111) surfaces cleaved in vacuum (10^{-7} to 10^{-10} mm) have been made using both the field-effect approach[1,2] and the channel method of Statz and his co-workers.[3]

In the field-effect measurements the portion cleaved off the sample was used as the field plate, and measurements were taken with fields up to 10^4 volts/cm. The field-effect measurements show a slightly n-type surface on both p- and n-type bulk material, of field-effect mobility of about 50 cm^2/v sec. The surface is extremely insensitive to oxygen admission, with up to atmospheric oxygen pressure producing negligible change in field effect, and no sudden changes of conductance with increasing pressure. The latter measurement is unreliable over long periods of time due to temperature drifts. Because of this insensitivity to ambient, the measurement cannot distinguish between a strongly n-type surface with a high density of states or a surface which is almost intrinsic.

To discriminate between the above techniques, the channel method of Statz was employed. Samples were made by diffusing phosphorus into 80-ohm-cm p-type silicon to form *npn* units and by diffusing boron into 20-ohm-cm n-type silicon to form *pnp* units. The "base" width was 0.04 inch. By cleaving so as to leave the junctions intersecting a cleaved surface, we were able to make measurements of the channel conductance, if any, caused by the cleaved surface. In neither the *npn* nor the *pnp* case was the conductivity of the cleaved surface greater than 10^{-2} μmho/square at 1.5 volts bias, indicating there was no channel (inversion layer) present. This can be compared, for example, with a conductance of about 90 μmho/square as measured by the Statz technique on a cleaved surface of 5-ohm-cm n-type germanium (*pnp* configuration).

Thus we conclude that the dominant surface states are near the center of the gap with a freshly cleaved silicon surface, if we assume the surface state structure independent of the bulk type.

This result is in disagreement with work on ion-bombarded surfaces, where Law[4] has found a p-type accumulation layer on p-type silicon after bombardment and annealing and has found that the surface becomes n-type after bombardment with 1000-volt argon ions. He has also stated without reference that earlier work showed a p-type surface on n-type silicon. Dillon and Farnsworth[5] have concluded via work function and photoelectric threshold measurements that a degenerate p-type layer is found on a silicon surface cleaned by ion bombardment and annealing.

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STORED ENERGY RELEASE BELOW 80°K IN DEUTERON-IRRADIATED COPPER*

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Experiments by Blewitt, Coltman, and Klabunde[1] on neutron-irradiated copper have shown that the energy released during annealing in the vicinity of 40°K, designated Stage I, is 1.6 calories/g per μohm cm of resistivity which anneals. This value is anomalously low and leads to doubts as to whether or not interstitial-vacancy mutual annihilation can be the recovery mechanism. Further, since the annealing observed in deuteron-irradiated copper is in some ways similar to that found in neutron damage, the doubt attaches also to the deuteron results. An experiment was therefore performed to measure the energy released after 11-Mev deuteron irradiation.

For the measurement, a specially designed differential calorimeter was constructed in which it was possible to measure all heat leaks as a function of temperature. This was required since the total anticipated energy release is small, and leaks are a significant part of the total effect. The magnitude of the energy released was limited on the one hand by the smallness of the specimen and on the other hand by the necessity to keep the total stored energy released per gram per temperature interval considerably less than the specific heat to avoid making the specimen thermally unstable.[2] The size of the specimen was limited by the deuteron beam size and range. The above requirements were met by using a $\frac{1}{2}$-g specimen,[3] 5×10^{-3} in. thick, in deuteron fluxes several times smaller than those which have been used in previous radiation-damage measurements and a relatively fast annealing rate of about 2°K/min. The heat leaks were minimized to an extent consistent with the requirement of reproducibility by using high thermal resistivity Advance-Chromel P thermocouple wires and pressures less than 10^{-5} mm Hg in the experimental volume.

Departures of the differential system from perfect symmetry were taken into account by use of a separate background annealing run, in which the specimen in an unirradiated state and its symmetric dummy were heated to 80°K, and subsequently cooled. This run was also used to measure the heat leaks and the specific heat of the specimen as a function of temperature. The important influence of the rapidly varying specific heat on the results as well as other aspects of the measurement will be discussed in detail in a later publication. A continuous recording of the output of a differential thermocouple between the copper foils was made during the anneal. From this recording, calculations could be made at temperatures as closely spaced as desired.

The results are shown in Fig. 1, where the energy released per gram per unit temperature is plotted in millicalories per gram-°K as a function of the annealing absolute temperature. Two irradiations and subsequent anneals were made: Run I to an integrated flux of 8.25×10^{15} deuterons/cm^2 and Run II to 2.89×10^{15} deuterons/cm^2. The part of the curves below 27°K is blurred by a complication due to experimental difficulties in fixing the starting point of the annealing, and