

I. PHYSICAL ELECTRONICS

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A. PHYSICAL ELECTRONICS IN THE SOLID STATE

1. CHARACTERISTICS OF SEMICONDUCTOR JUNCTIONS

Measurements of the voltage-current characteristics of p-n junctions, which were previously confined to regions of small voltage and currents, are being extended to include breakdown in the reverse direction and ohmic conduction in the forward direction.

The reverse characteristics of a junction in silicon (Quarterly Progress Report No. 52, p. 3) show the expected behavior in the reverse direction. The extended measurement of the characteristic in the forward direction exhibits a single slope on a semi-logarithmic plot, which is difficult to reconcile with the barrier recombination picture of Sah, Noyce, and Shockley (1). A closer examination of the theory of the transition region may clear up this discrepancy.

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References

1. C. T. Sah, R. N. Noyce, and W. Shockley, Carrier generation and recombination in p-n junctions and p-n junction characteristics, Proc. IRE 45, 1228 (1957).

2. SURFACE STATES ON SEMICONDUCTORS

As reported in Quarterly Progress Report No. 52, page 4, nonlinear photoconductive response characteristics were reproduced in a germanium sample mounted in a demountable brass vacuum tube. The transient response to light was relatively slow, and the oscilloscope trace was rounded – the more nonlinear, the rounder it was. The nonlinearity appeared when oxygen was introduced into the vacuum and sparked with a Tesla coil, and disappeared when the gas was pumped out.

The experiment was repeated in a glass tube. The crack in the glass was sealed with Apiezon Q compound. Introduction and sparking of oxygen produced nonlinearity of response, but the transient response was practically immediate. This seems to be at variance with the idea expressed in the last report that the nonlinearity might be caused by slow surface states. The preparation of the sample was different for the glass tube, and that might have been a reason for the difference in transient response.

A new source of steady light has been added to the optical system, and its effect is to subtract the nonlinear part of the response curve from the total curve. With this

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"floodlight" on, the response decreases but becomes linear. The change in conductivity arising from this new source of light is still negligible compared with the total conductivity. This device is similar to one used by Hornbeck and Haynes (1) to "erase" the effect of traps by saturating them with minority carriers.

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References

1. J. A. Hornbeck and J. R. Haynes, Trapping of minority carriers in silicon. Part I. p-type silicon, Phys. Rev. 97, 311 (1955).

B. EXPERIMENTAL TECHNIQUES

1. TRANSISTORIZED-VACUUM-TUBE ELECTROMETER

The basic features of this instrument were described in Quarterly Progress Report No. 52, page 4. The addition of a transistor current amplifier stage and other modifications to the original amplifier design have resulted in a dc amplifier circuit with a gain before feedback of approximately 10,000. Work is being directed toward improving the response of the system to square-wave current pulses of less than 10^{-9} amp.

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