TRW SPACE TECHNOLOGY LABORATORIES

THOMPSON RAMO WOOLDRIDGE INC.

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24 March 1965

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National Aeronautics and Space Administration
Goddard Space Flight Center
Glen Dale Road
Greenbelt, Maryland

Attention: Mr. M. Schach
Code 633

Subject: Monthly Progress Report
Period Ending 1 March 1965
Contract NAS5-3805
Report No. 4161-6011-SU-000

I. Progress in This Report Period

A high energy electron experiment was conducted on 6 March 1965 utilizing a 3 Mev electron Van de Graaff located at Shell Development Company in Emeryville, California. Experiments were performed at energies of 1.0, 2.0, and 3.0 Mev. The specimens irradiated consisted of n-type silicon, with resistivities of 1 ohm-cm and 100 ohm-cm and p-type silicon with resistivities of 150 ohm-cm, 75 ohm-cm, and 15 ohm-cm. Postirradiation Hall effect measurements are currently in process and not yet complete. Some of the preliminary data obtained to date, however, appears quite interesting and will be discussed in some detail here.

The principal objective of this experiment was to obtain valid and meaningful information on the defect introduction rates in the range from 1 to 3 Mev. This requirement existed due to the failure on a previous experiment utilizing the GA linac to obtain meaningful data at these energies. Although the GA linac performs quite well in the energy interval from 5 to 45 Mev, operation of this unit in the 1 to 5 Mev region is extremely difficult. Although operation in this region was performed in our last experiment, the data clearly indicated that the accuracy of the actual electron energy obtained was not sufficient to allow the acquisition of meaningful data. Hence, an additional experiment was performed using the 3 Mev Van de Graaff.

The 150 ohm-cm p-type silicon irradiated in this experiment was cut from the same crystal that has been used throughout this program for the high resistivity p-type data. As has been reported*, the electron energy dependence of the $E_V + 0.29$ level has not shown agreement with the energy dependence of the observed degradation of minority carrier lifetime in solar cells. For this reason a new group of crystals was obtained with resistivity more nearly alike the resistivities representative of commercial solar cells. The specimens irradiated in this experiment from these crystals were 15 ohm-cm and 75 ohm-cm p-type silicon. Initial measurements on these specimens indicate an energy dependence steeper than that previously obtained on the 150 ohm-cm p-type specimens; in fact, these lower resistivity specimens yield energy dependences very similar to the observed degradation of minority carrier lifetime in p-type silicon. In order to substantiate this trend, additional specimens from all three crystals were irradiated at 11.5 Mev on the GA linac. Although these data are also not yet resolved completely, the trend appears to be substantiated. If further data reduction confirms the observed preliminary information, several conclusions may be drawn. First, since the difference in doping between 75 ohm-cm and 150 ohm-cm p-type silicon is rather small, there would appear to be a dependence on the effect which is controlled by either the thermal history of a particular crystal or the type and concentration of impurities therein. Second, since both the 15 and the 75 ohm-cm crystals appear to exhibit energy dependences similar to observed minority carrier lifetime degradation, the possibility that the same defect level is responsible for both observed effects is supported. This particular defect level at $E_V + 0.29$ ev has been referred to as a divacancy. The n-type specimens irradiated in this experiment exhibit data in good agreement with that previously reported.

II. Anticipated Activities During the Next Report Period

The Hall effect measurements on the specimens irradiated from 1 to 3 Mev on the Shell Development Company's 3 Mev Van de Graaff and the specimens irradiated at 11.5 Mev on the GA linac will be completed. In addition, the low energy proton experiments initiated in January, 1965 will be completed now that chamber and accelerator modifications have been performed.

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*R. G. Downing and J. R. Carter, Jr., "Charged Particle Radiation Damage in Semiconductors, X: The Energy Dependence of Electron Damage in Silicon," Contract NAS5-3805, 4161-6004-KU-000, dated 3 September 1964.

III. Manpower Expended in This Report Period

MANPOWER EXPENDITURES

NAS5-3805

Period 1 February - 26 February

	Total
J. R. Carter	160
R. G. Downing	65
H. Y. Tada	12
Total	237

Respectfully submitted,

R. G. Downing
Project Manager

Approved:

J. M. Denney, Director
Solid State Physics Laboratory

RGD:rct