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RADIATION EFFECTS ON SILICON SOLAR CELLS

Third Monthly Progress Report Covering the Period
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This monthly report covers the fourth month of research on Contract Nc. NAS7-91, Radiation Effects on Silicon. During this period the preparations for the irradiation experiments have been continued. Samples of n-type silicon with phosphorus doping, both floating-zone and pulled material, have been prepared for accelerator irradiations. It would have been possible to perform irradiations on a sample for infrared spectroscopy, but it was decided first to irradiate other samples to measure Hall coefficient so that an irradiation duration could be determined which would remove roughly 75% of the carriers in the sample to be used for infrared studies.

The data has been reduced from one sample of pulled silicon, which was irradiated at room temperature and on which the carrier lifetime was measured as a function of temperature before, during and after irradiation. The temperature dependence of the lifetime after irradiation indicates a slope with an activation energy of 0.16 ev, in reasonable agreement with the activation energy for the A center.

An analysis has also been performed to predict the temperature dependence of the Hall coefficient, carrier mobility and lifetime for an assumed set of concentrations of dopants and A centers. These predicted values will be compared with experimental results to evaluate the consistency of the model of the A center creation. It is expected that the next quarterly report will devote a section to this analysis, as well as the comparison with experimental results.

The evaluation of previously published experimental data is continuing and will be reported in the next quarterly report.

An analysis of the dependence of carrier lifetime on various parameters, including the injection level, is being performed for application to the experimental program. This analysis is based on the original work by Shockley and Read(1) and two articles by Nomura and Blakemore.(2,3)

The design of the ESR cavity and the cryostat have now been completed. The cavity is cylindrical and operates in the TE_{011} mode. The degenerate TM_{111} mode is suppressed by using insulators between the cylindrical cavity and its end plates. The sample is placed on the axis of the cylinder. A cavity of this design has been built from brass to study the effect of sample size on the cavity frequency and Q. The final cavity will be constructed from Pyrex precision bore tubing, silvered on the inside.

The cryostat is designed to enable irradiation, ESR measurements and annealing to be carried out in the same assembly. The sample is mounted on a rod which can be moved up and down through a Wilson seal. At various vertical positions are the irradiation station, the ESR cavity, and an annealing oven. The cryostat will be made of stainless steel and the irradiation station will have thin stainless steel windows. Since this region may become ferromagnetic under irradiation at low temperature, the ESR cavity will be a suitable distance away. The sample rod can be rotated to allow the study of orientation effects. By raising the sample further it can enter an oven where annealing can take place. Cooling during irradiation will be by flow of liquid past the sample to discourage adherence of gas bubbles which can cause severe problems with heat transfer.

PERSONNEL

The following personnel have participated in this research program during this period:

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