RADIATION DAMAGE

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The radiation damage workshop considered a variety of topics among which were the need for equivalent electron fluences in gallium arsenide, the possibility of 15 percent end-of-life efficiencies for silicon, increasing radiation resistance in gallium arsenide, annealing of radiation damage and the need for radiation damage studies in cascade cells.

The workshop members agreed that a high priority should be assigned to obtaining equivalent electron fluences for gallium arsenide cells. It was suggested that 1 MeV would be a reasonable electron energy for this purpose. Special care should be given to proton irradiations particularly for energies below 1 MeV. In addition, omnidirectional rather than normal incidence protons should be used. It was also agreed that there was a need for obtaining damage coefficients in gallium arsenide. In silicon, there is a requirement for additional flight data, especially in proton dominated orbits. These data are needed to further check the accuracy of the 1 MeV equivalence fluences.

Attainment of 15 percent end-of-life efficiencies, after 10 years in geosynchronous orbit, was judged to be a practical goal for silicon. This is conditioned on attainment of BOL efficiencies of 16 to 18 percent. Several cell types were suggested as possible candidates, provided the required efficiencies could be attained. Configurations suggested were the structure proposed by Martin Wolf at the present conference, gallium-doped thin drift field cells, gallium-doped vertical junction cells, if used with heavy backshielding, and 0.1 Ω-cm cells if annealable. Defect concentrations should be kept low in the starting silicon.

Several approaches show promise for attaining increased radiaton resistance in gallium arsenide solar cells. The major radiation induced defect, located at midgap, is vacancy and stoichiometry related. Processing to minimize the concentration of this defect in the starting material and irradiated cell would be desirable. Decreased junction depths, especially in the present AlGaAs/GaAs heterojunction cells, together with use of better quality substrates should lead to increased radiation resistance. Radiation damage research using techniques such as DLTS should be correlated with the processing and fabrication procedures and used as a guide to further improvements.

Reduction of annealing temperatures below 200°C together with decreased annealing times are desirable goals for both silicon and gallium arsenide cells. The efficacy of periodic versus continuous annealing was considered, and it was concluded that additional data are needed to decide between the two techniques. Some concern was expressed concerning possible methods to accomplish annealing in space. Although no method was specified, several members of the workshop felt that accomplishing this in practice would present highly undesirable problems in spacecraft design and operation. However, it was pointed out that pulsed current annealing had accomplished defect reduction and performance recovery in gallium arsenide cells and that this technique, if used, would present a minimum of problems to spacecraft design and operation. At any rate, the question of how to accomplish annealing in space deserves further consideration.

In addition to damage removal, it was suggested that studies of annealing kinetics could be pursued as a technique to characterize radiation defects. This would be especially important for gallium arsenide where defect identification is difficult and minimal. Radiation damage and annealing studies, in cascade cells, were considered but assigned a low priority. These studies, if pursued should at present be used to redirect materials related research in the cascade cell area.

In summary: The need for 1-MeV damage equivalent fluences in gallium arsenide was emphasized. End-of-life efficiencies of 15 percent after 10 years in geosynchronous orbit were considered attainable for silicon, and suggestions were offered to attain this goal. Radiation resistance in gallium arsenide can be increased by improvements in processing and fabrication, which should be correlated with the results of defect studies. Annealing studies should continue in both silicon and gallium arsenide. These should have the twofold goal of reducing annealing temperatures and aiding in defect characterization especially in gallium arsenide. Finally, consideration should be given to devising a simple method for achieving annealing in space.

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