CELL RESEARCH AND TECHNOLOGY WORKSHOP

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Four major areas were considered in this workshop. These were (1) the silicon cell, (2) the GaAs cell, (3) the multibandgap cell, and (4) novel ideas. In each area we considered material research issues, cell research issues, and the cell technology that needs development.

THE SILICON CELL: The areas of technical concern that were itemized included base resistivity, cell thickness, back (and front) surface field layers, back (and front) surface passivation, contact area, passivation under contacts, surface texturization vs broad band AR coatings, ion-implanted vs diffused emitters, and radiation hardness (Lithium doping, thin emitters, lead doping).

Among the questions raised concerning the silicon cell were:

1. What can GaAs researchers learn from Si technology?
2. Can the new, high efficiency Si cells be manufactured?
3. What about Pb doping to enhance radiation tolerance?
4. Are top contacts reliable for high voltage (700 mV) cells?

It was generally agreed that:

1. 16 percent AM0 silicon cell can be manufactured.
2. 18 percent AM0 is still a good goal for the planar junction silicon cell.
3. Surface passivation is a key barrier. Promising approaches to SRV control include the use of GaP isotype heterojunction, a-Si:H, and SIPOS.
4. Texturized surfaces may be good for some applications, but cell heating problems certainly have to be addressed.
5. Both ion implantation and diffusion result in comparable efficiencies.
6. User requirements should be driver in cell development funding.

Recommendations for silicon research:

1. Surface passivation techniques should be developed, especially critical for low resistivity cells. Recommended approaches include GaP isotype heterojunction, a-Si:H, poly Si, thermal SiO_2, PC-CVD, and SIPOS.
2. Techniques for passivation under contacts should be developed.
3. Subsequent to the solution of the SRV control problem, thin cell technology should be developed, both for high efficiency and radiation hardness.

THE GALLIUM ARSENIDE CELL: The areas of concern that were brought up included the N/P vs P/N argument, means of passivating both N-type and P-type surfaces, the use of graded bandgap structures, manufacturability, scaleability, cost vs efficiency, material purity, growth processes - LPE vs OMCVD, and cell thickness.

The questions raised concerning the GaAs cell were:

1. What limits performance of GaAs cell?
2. Is substrate development required (cutting, polishing, cleaning, QC, etc.)?
3. Is OMPVE improvement required?

4. OMVPE or LPE Layer perfection, thickness control, window composition, safety issues (AsH_3 vs TMAs).
5. What are the radiation induced defects in GaAs?
6. What is the status of defect passivation technology?
7. What causes voltage and current degradation during array fabrication?
8. What are the causes of metallization stability?
9. What role do thermal and mechanical stresses have on cell performance?

Conclusions/recommendations for GaAs research:

1. SRV control key issue here, also. Research needed to determine adequate passivation techniques.
2. Substrate materials also need improvement.
3. Higher utilization of OMVPE materials required.
4. The purity of Ga, Al, and As dopant sources must be improved.
5. LPE vs OMVPE question not answered. OMVPE offers higher throughput and better thickness control.
6. GaAs planar cell efficiency arbitrarily set at 20 percent higher planar silicon cell efficiency, based on past experience.
7. Experimental/theoretical research needed to understand radiation effects on both bulk and junction.
8. N/P vs P/N not clear experimentally.
9. Users need GaAs thickness less than 1/2 that of present silicon cell thickness.

THE MULTIJUNCTION CELL: The following questions/issues were raised:

1. Monolithic vs mechanical stack?
2. 2 vs 4 terminal?
3. What is best top cell material for two layer stack (AlGaAs vs GaAsP)?
4. What is best bottom cell material for two layer stack (Si, Ge, InGaAs, GaAsSb)?
5. What are the prospects for a 25-30 percent AMO cell in the near term, far term?
6. What are the stresses on the multibandgap cell in the space environment?

The following conclusions were generally agreed to:

1. Beginning of life efficiency: 2 junction 25 percent, 3 junction 30 percent.
2. End of life efficiency: 2 junction ??, 3 junction ??.
3. Near term goal should be a mechanical stack.
4. Far term goal should be a monolithic stack.
5. Top cell materials: AlGaAs or GaAsP.
6. Bottom cell materials: monolithic Si or InGaAs, mechanical GaAsSb.

NOVEL CELLS: The following three suggestions were briefly discussed:

1. A GaAs thin cell on a GaP substrate.
2. Compositional superlattices or NiPi cells.
3. InP radiation hard cell.