MULTI-BAND GAP AND NEW SOLAR CELL OPTIONS WORKSHOP

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Question 1. Are greater than 2 terminal (2T) cells really useful?

Number of terminals	Advantages/disadvantages
2T	direct replacements for existing cells
3T	no interest; no perception of useful applications; good for separate cell analysis during development
4T	could be useful; 4T controllers and power conditioning equipment could be developed; even if cells are 4T, module level will likely be 2T; users want 2T. Cost must be in line with advantages.

For most missions, 2T are preferred, but for compelling reason (radiation resistance, efficiency?), 4T cells could be preferred and used.

Questions 2. Will radiation damage prevent development of MBG cells for space?

Probably not.

-Junctions in MBG cells will degrade at different rates. Cells can be designed for BOL or EOL matching. This adds flexibility to MBG designs but requires attention to detail.

-GEO likely to be most populated orbit with increasing use of LEO. Not as radiation intense. High efficiency in "hot" mid orbits make MBG attractive if radiation resistant.

-Ground testing needs to be realistic to convince users that MBG cells are radiation resistance and 1-meV electron equivalent testing is useful; MBG cells **must** reach a level of performance (25%?) to justify radiation testing.

Question 3. Is lattice matching critical for MBG cells?

Yes, for monolithic cells. No, for mechanically stacked cells

Threading dislocations that result from mismatch will degrade cells, i.e., lower BOL. However, may have smaller efficiency deltas at EOL.

Concentrator cells can tolerate some dislocations.

Related questions:

-Are monolithic cells far-term and stacked cells near-term or vice-versa?

-What are the capitalization costs of automation?

-What is the cost differential between monolithic and stacked cells?

-What is the interconnect cost difference? reliability difference?

Tandem technology is still in development stage;

-2-junction (2-J) monolithic devices probably will not reach 30 percent; 3-J devices may.

-2-J stacked cells may reach 30 percent

When the payloads increase to the points that arrays must be redesigned, then there exists a cost delta drive for higher efficiency cells. There are current applications where 22-23% efficient radiation hard cells would be attractive.

Question 4. How is true performance measured?

The problem is with the spectral content of simulators, particularly for low-band-gap cells. Calibration requires single junction reference cells for each of the subcells in the stack. Reference cells for buried subcells in the stack must be calibrated with simulted top cells in place.

Cells should be measured at intended operating temperature.

More frequent NASA jet flights and independent measurements are needed.

Question 5. Can greater than 30% be achieved in planar cells? Cost?

Yes. It is theoretically possible, 3-J, AlGaInP/GaAs/Ge, for example.

-High operating temperatures will make 3rd, low band gap cell almost useless.

-2-J devices will probably not exceed 30%, unless concentrated.

Cost?

-Boeing estimated $70M development costs for GaAs/GaSb concentrator.

-A monolithic MGB may will only be 10-20% more than 1-J analog.

-There will be associated costs related to yields, throughput, etc.

-TBD!

Question 6. What is the future of II-VI materials for MGB devices ?

Viewed as far-term; not much interest. II-VI's may be useful for buffer layers or window layers in the near-term.

Question 7. Quaternaries?

-e.g., AlGaInP, GaInAsP

-If there is a real need for 30% flatplate cells, it will likely require the use of AlGaInP or GaInAsP in 3-J cells.

-The main problem with quaternaries is the necessity to control composition and for AlGaInP, the sensitivity of the electronic quality to oxygen and water contamination.

CLOSING REMARKS:

If we are to fly MBG cells by year 2000, we need to freeze design soon, begin characterization and bring to production.

Cost of this? Hard to say. Maybe $15-$20M. Could be answered by man-tech program.