THE NASA LEWIS RESEARCH CENTER PROGRAM IN SPACE SOLAR CELL RESEARCH AND TECHNOLOGY

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ABSTRACT

The NASA Lewis program in space solar cell research and technology has as its objectives to improve conversion efficiency, to reduce mass and cost, and to increase the operating life of solar cells and blankets. The major thrusts of the program are to produce an 18%-AMO-efficient silicon solar cell, to effect substantial reduction in the radiation damage suffered by silicon solar cells in space, to develop high efficiency wrap-around contact and thin (50 μm) coplanar back contact silicon solar cells, to substantially reduce the cost of silicon cells for space use, to develop cost-effective GaAs solar cells, to investigate the feasibility of 30% AMO solar energy conversion and to develop reliable encapsulants for space blankets. The major targets and milestones that guide this program are shown in figure 1. The major targets are shown within ellipses.

The major solar cell and blanket development activities are shown in figure 2. In the 18% cell development area, substantial progress has been made in understanding voltage limiting mechanisms. Silicon cells with voltages of about 645 mV have been fabricated by three techniques. Because of this progress, a contract to develop an 18% efficient cell is anticipated.

Significant increases in the understanding of radiation damage have also occurred. The three defects responsible for performance degradation have been identified and schemes to prevent their formation are under study. Alternative means for removing damage, such as annealing or use of healing additives, are under study. Additionally, cell designs that should show improved performance in a radiation environment are being persued.

Development of the 14% efficient, high efficiency wrap-around contact cell is proceeding. This cell is 200 μm and has dielectric edge insulation. Thin (50 μm) interdigitated back contact cells are being developed on contract, with the goal of achieving 13% efficient cells.

Low cost area cells with areas of at least 25 cm^2 are going to be developed under contract. Previous effort has established the feasibility of a number of low-cost, high-volume processing steps that should enable high performance, space quality cells to be produced for costs under $5/W.

A new program area is being initiated to develop cost-effective, radiation-resistant GaAs solar cells. One promising approach that is being supported is at MIT Lincoln Laboratory for the n/p CVD shallow junction cell.

The types of missions that GaAs cells would be suited for are also under study. Another area of new program development lies in the domain of 30% solar energy conversion. The feasibility of achieving this efficiency is presently being assessed.

The primary focus of blanket technology is the development of practical thin encapsulants for solar cell blankets. The feasibility of electrostatic bonding of 50-75 μm 7070 cover glasses has been demonstrated. Additionally, a variety of different types of encapsulants such as silicones and glass resins are being evaluated for their durability to space UV and particulate radiation.

In summary, the NASA Lewis Research Center program in space solar cell research and technology seeks to understand and eliminate barriers to achieving 18% silicon cell conversion efficiency, to develop and implement the technologies necessary to produce radiation resistant, high efficiency, and low cost solar cells and blankets. New programs of GaAs cell development and 30% conversion devices are beginning. Significant progress has been made in all areas of research.

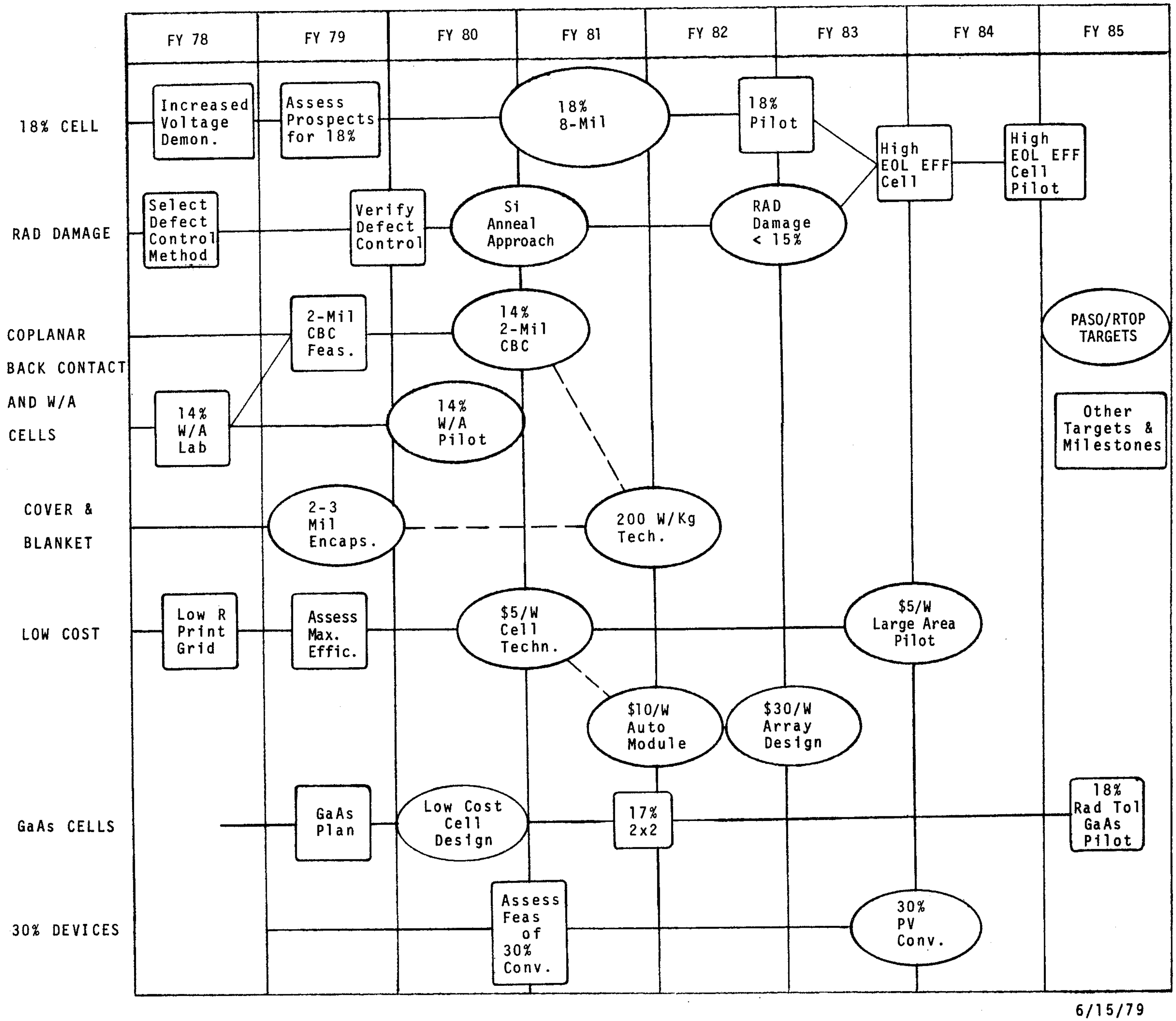

Figure 1.- Lewis solar cell and blanket research-and-development activities.

18% CELL

- STUDY OF RECOMBINATION CENTERS IN 0.1 Ω-CM SI, U. FLA.
- DEVELOPMENT OF 18% EFFICIENT SI SOLAR CELL (NEW CONTRACT).
- DIFFUSED TAILORED JUNCTION (I-H).

RADIATION DAMAGE

- FUNDAMENTALS OF RADIATION TOLERANCE IN SI SOLAR CELLS, SUNY-ALBANY.
- SOLAR CELL PROCESSING FOR IMPROVED RADIATION TOLERANCE, SPIRE CORP.
- MICRODISTRIBUTION OF RADIATION DAMAGE IN SOLAR CELLS, MIT.
- LASER ANNEALING OF RADIATION INDUCED DEFECTS (NEW).
- RADIATION RESISTANT THIN NIP CELL, COMSAT CORP.
- RADIATION DAMAGE EFFECTS (I-H).

COPLANAR BACK CONTACT

- THIN INTERDIGITATED CELL DEVELOPMENT, SOLAREX CORP.
- THIN INTERDIGITATED CELL DEVELOPMENT, (NEW).
- CBC PROTOTYPE DEVELOPMENT (I-H).
- HIGH EFFICIENCY W/A CONTACT SOLAR CELL DEVELOPMENT, SPECTROLAB, INC.

LOW COST CELL TECHNOLOGY

- LOW COST, LARGE-AREA SI CELLS (NEW).
- LARGE-AREA, LOW COST CELL DEVELOPMENT (I-H).

GAAs SOLAR CELLS

- GAAs CVD HOMOJUNCTION SOLAR CELL DEVELOPMENT, MIT LINCOLN LABORATORY, (BEING NEGOTIATED).
- GAAs CELL DEVELOPMENT (I-H).

30% DIRECT SOLAR CONVERSION

- 30% CONVERSION ANALYSIS (NEW).
- 30% CONVERSION ANALYSIS (I-H).

SOLAR CELL BLANKET TECHNOLOGY

- COVER EVALUATION (NEW).
- ESB MODULE DEVELOPMENT (NEW).
- EXPLORATORY DEVELOPMENT AND EVALUATION (I-H).

Figure 2. - Solar cell development activities.